CAHNERS PUBLICATION
OCTOBER 20, 1976

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EDN

XCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

A common sense approach to your μP application

Computer systems—build, buy or modify?

Connector systems—old standbys face a bright future

IS
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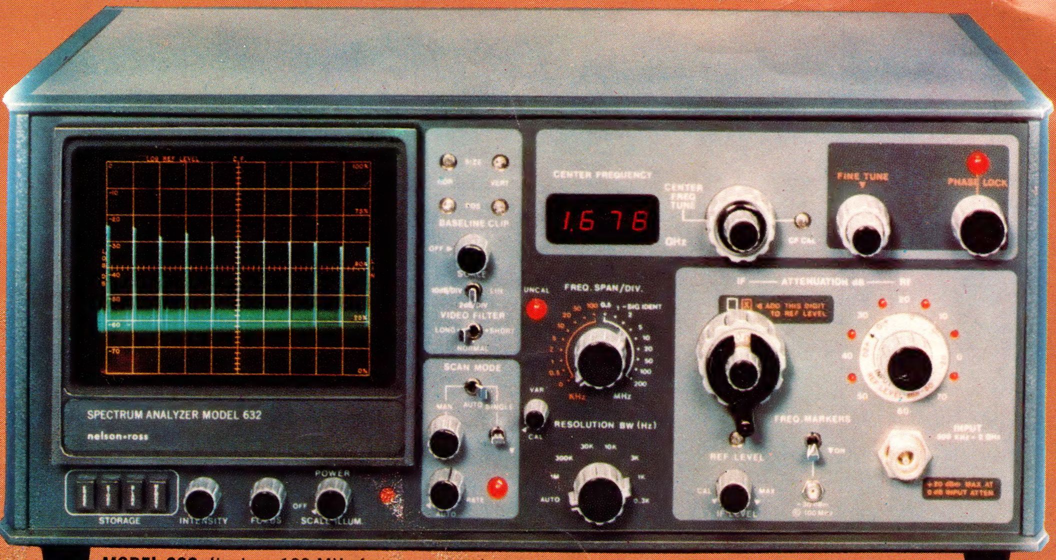
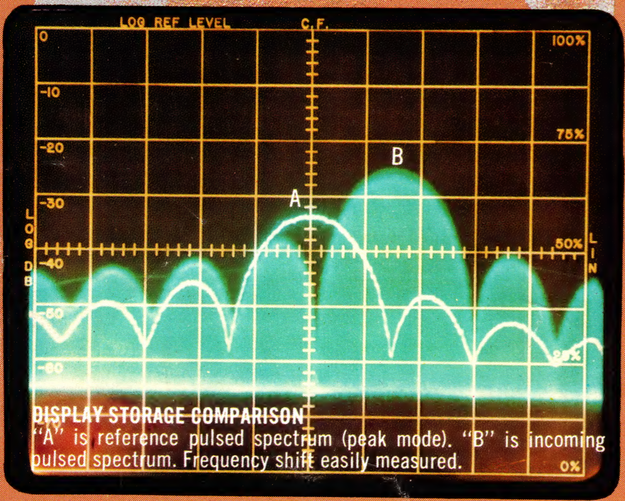
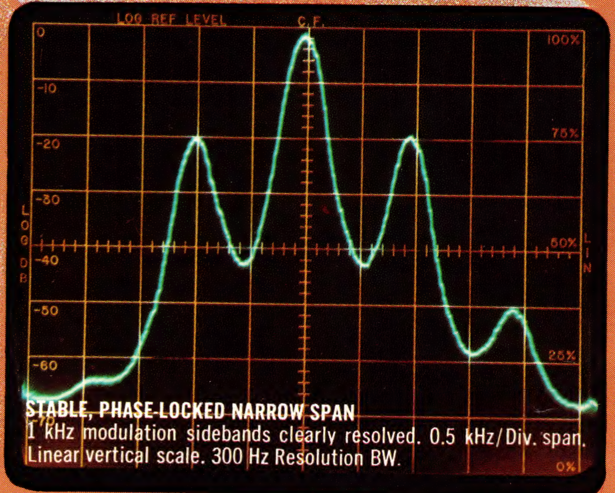


MODEL 632 displays 100 MHz frequency marker "comb".



DISPLAY STORAGE COMPARISON
"A" is reference pulsed spectrum (peak mode). "B" is incoming pulsed spectrum. Frequency shift easily measured.



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- ☐ Interface for Tracking Generator (Optional)
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640	630 plus Internal Preselector	$10,150
631	10 MHz to 40 GHz 6 Bands	$ 7,150
641	631 plus Internal Preselector	$ 9,500

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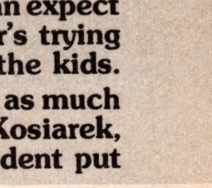

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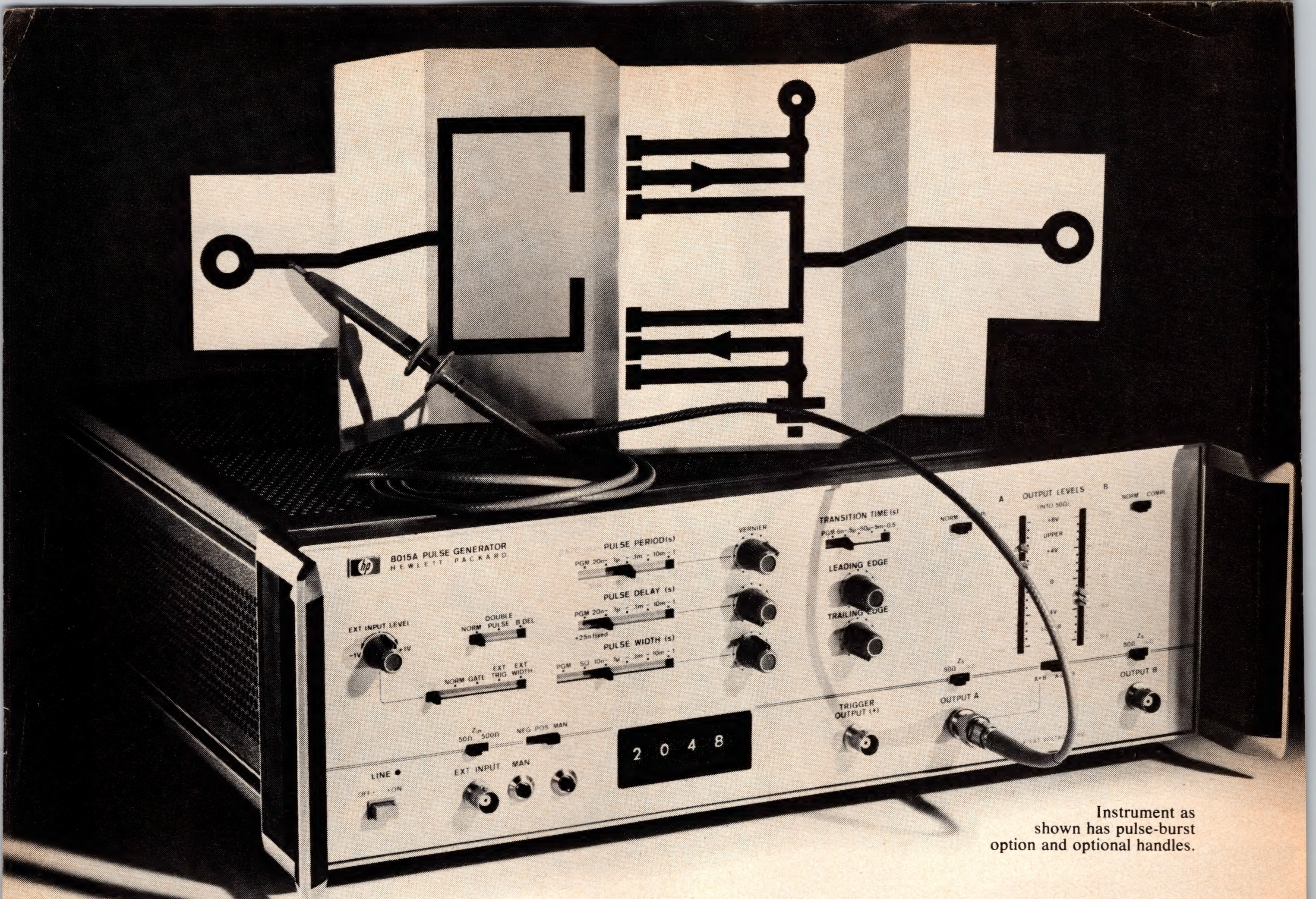

Instrument as
shown has pulse-burst
option and optional handles.

CMOS parametric testing makes special demands... Meet them with HP's 8015A Pulse Generator.

This pulse generator has standard features and options that make it ideal for MOS and CMOS parametric testing. For example:

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And TTL Output (option 005) gives you a separate TTL compatible, 50-ohm output that tracks channel A output with fixed TTL levels.

The 8015A, starting at $2,250*, gives you parametric testing flexibility and saves valuable setup time.

Or, if your need is for functional CMOS testing, consider HP's 8011A. Priced at just $525*, it gives you high amplitude (to 16V) pulses at rates from 0.1 Hz to 20 MHz, and offers the Pulse-Burst Option.

Contact your local HP field engineer for all the details. Or, write for the 8015A and 8011A data sheets and our Application Note 195 — "Pulse Generator Techniques in CMOS Applications."

*Domestic U.S.A. prices only.

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OCTOBER 20, 1976
VOLUME 21, NUMBER 19

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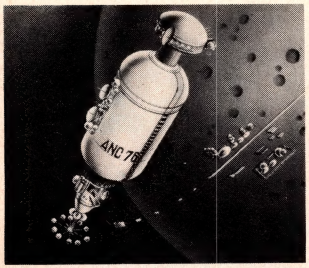
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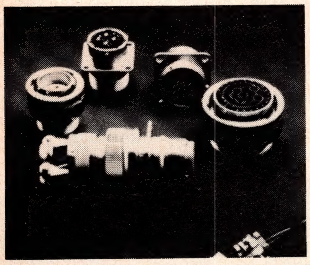
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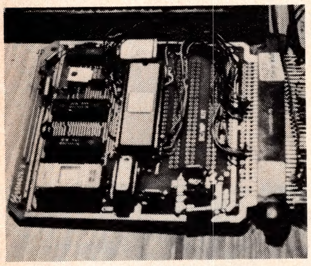
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COVER

While all indications point to a "starry" future for fiber-optic connectors, other areas of connector systems show extensive design activity as well. Using a connector supplied by the Amphenol RF Div. of Bunker Ramo, Art Director Dan Kicilinski created our cover to go with the story that begins on pg. 54.

DESIGN NEWS

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µP APPLICATION IDEAS 43
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Connectors no longer fit into the "nuts-and-bolts" mold. Today, they can be as crucial to success as any exotic active component.

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Clothing manufacturers survive only if their products fit well and please the user. There's a moral here for computer-room suppliers.

Take a common-sense approach to your µP application. 85
EDN uses its hands-on experience to get acquainted with and apply the SC/MP µP as the basis for some down-to-earth advice.

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When fasteners are absolutely necessary, take advantage of unusual, but very functional, materials devices and techniques.

Is there a best approach when choosing a computer system? 105
Computer systems must frequently meet an end user's particular needs. But system and/or component selection is not a simple process.

DESIGN AWARDS 119
Test kit determines Gunn-diode threshold parameters . . . This flame detector interfaces directly to a µP.

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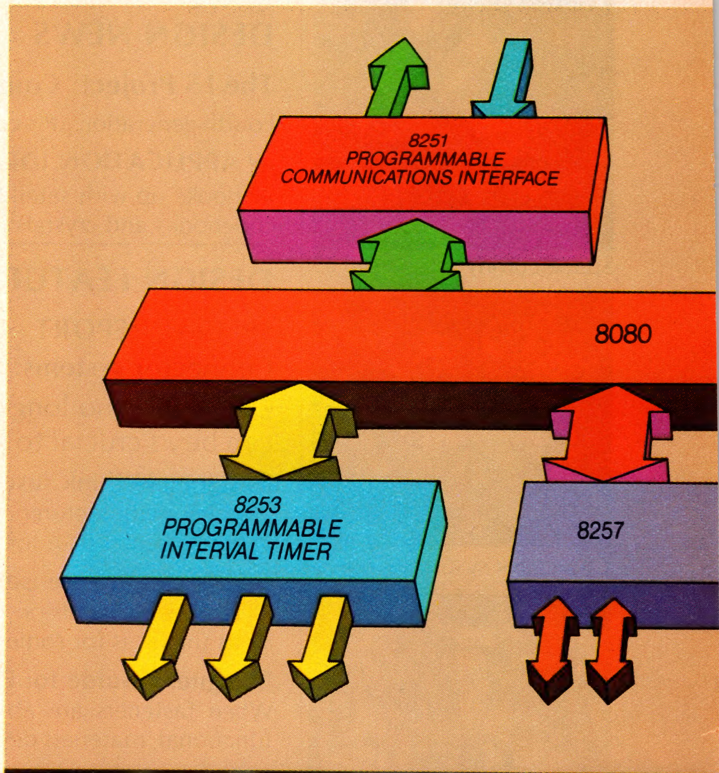
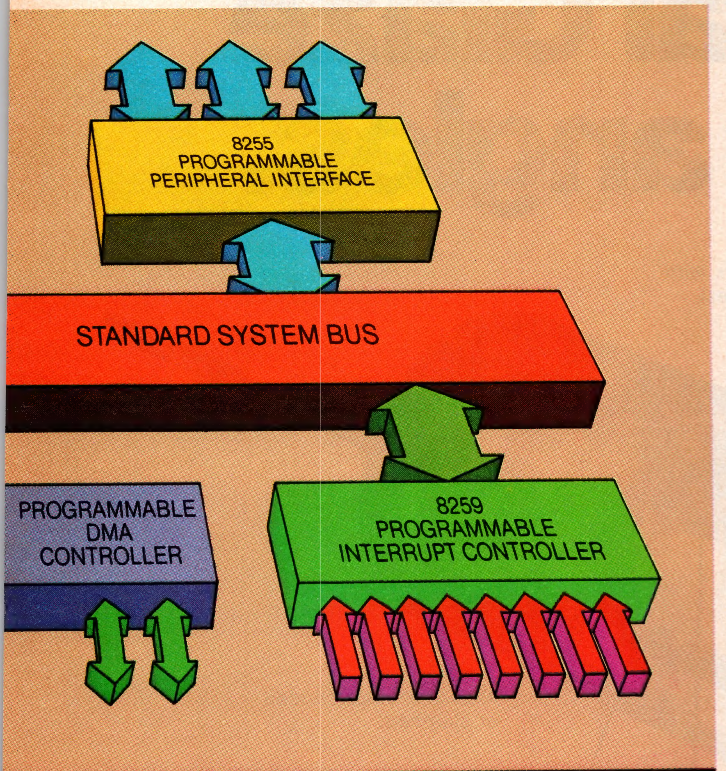
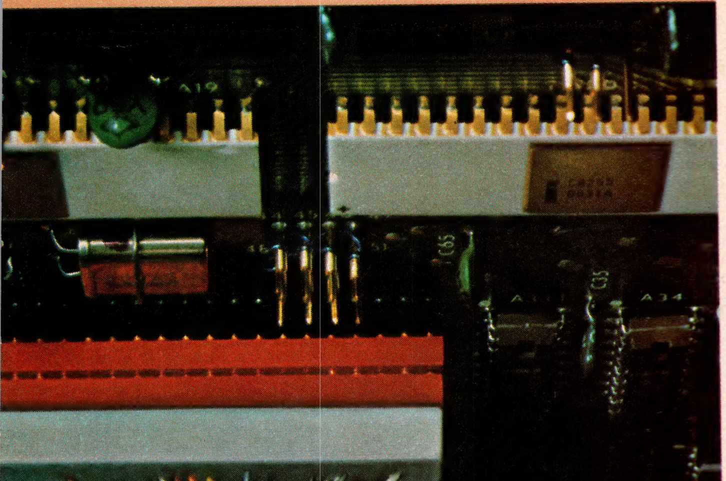


get you to market first.





munication protocols, including IBM Bi-Sync. For "parallel I/O," each 8255 Programmable Peripheral Interface gives you 24 versatile I/O lines to interface relays, motor drives, printers, keyboard/display and other parallel equipment.

Once you've selected the peripherals to fit your application, use the Intellec® Microcomputer Development System for both software and hardware development. Using the Intellec CRT terminal, call up the resident text editor. Write the source program to initialize the peripheral and the subroutines for peripheral/system operation. Then you assemble or compile the source programs into an object file using resident macroassembler or resident PL/M compiler—and store the object file on the Intellec diskette. With the relocation and linkage capability of the Intellec ISIS II diskette operating system, these routines can be added to a system library and called from user programs as needed. Once the main system program is written, the new peripheral device routines are easily linked in. The entire program is now ready to be run on your prototype via the Intellec ICE-80™ in-circuit emulation module. ICE-80 lets you debug your software and hardware in your actual prototype environment. Move from system integration and debugging to production in a fraction of the time previously required.

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To order the new peripherals, contact our franchised distributors: Almac/Stroum, Components Specialties, Components Plus, Cramer, Elmar, Hamilton/Avnet, Industrial Components, Liberty, Pioneer, Sheridan or L.A. Varah. For your copy of our 8080 System brochure write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051.

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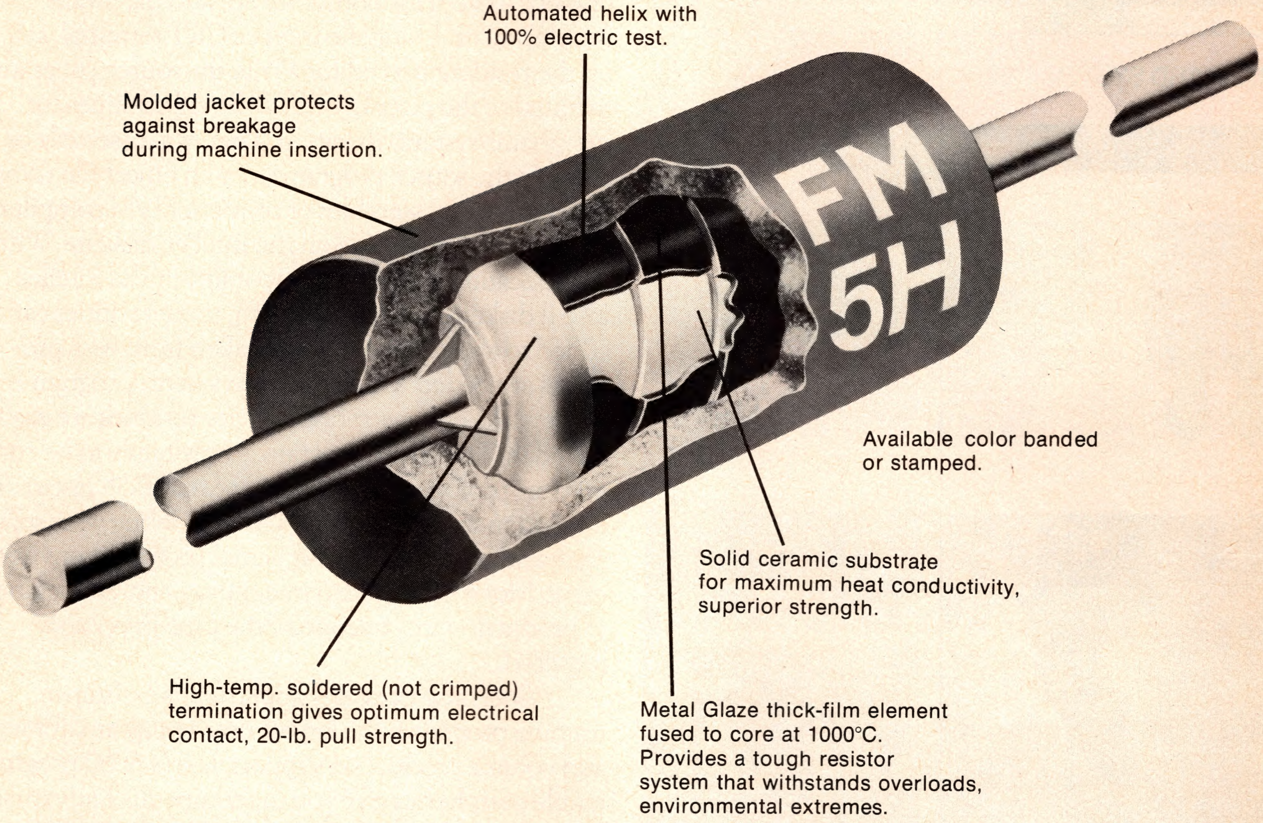
It pays to look into Metal Glaze™ from all angles.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system that withstands overloads,
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*™Metal Glaze is TRW trademark for its thick-film resistors.

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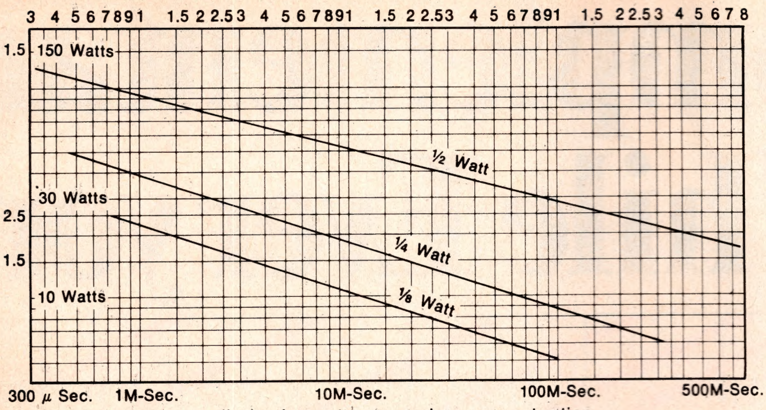
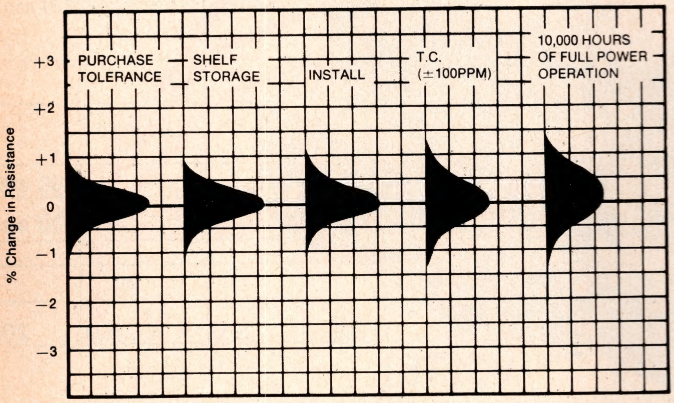


Note: Average power dissipation not to exceed component rating.

Overload Protection

Rugged Metal Glaze construction provides excellent power surge capability. A ¼w unit will conservatively operate within specifications when exposed to 18w, 10msec pulses, provided average power, and max voltage ratings are not exceeded. Ask us about your applications, including those requiring steady state conditions exceeding mil rated power.

TYPICAL TO-55 DESIGN TOLERANCE



Minimum Design Tolerance

(Design tolerance = a statistical summation of various parameters including load life, TCR, installation, and moisture resistance) All the features of Metal Glaze Resistors result in tight, predictable design tolerances which can be as low as ±1.5%, depending upon your application.

**TYPICAL DISTRIBUTION OF
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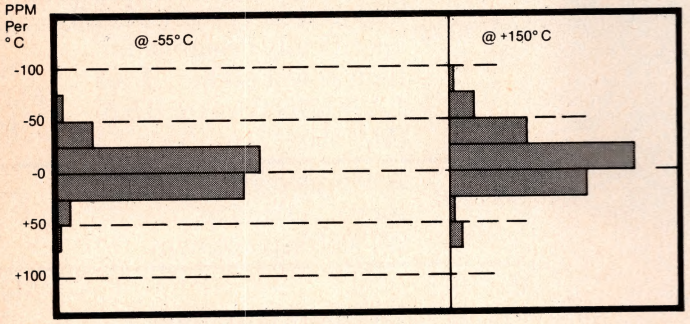

Absolute, Linear TCR

T.C.'s of 50, 100, or 200ppm are specified across the entire resistance range from 1Ω to 1MΩ. Our TC characteristic is essentially linear with temperature, and is a normal distribution centered near zero.

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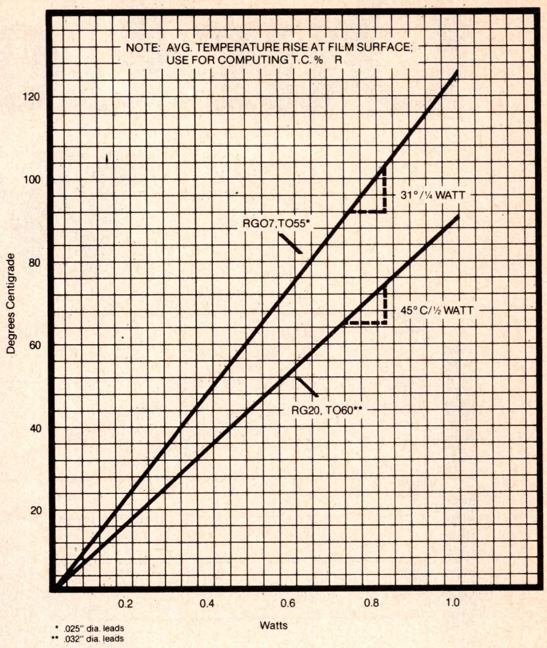
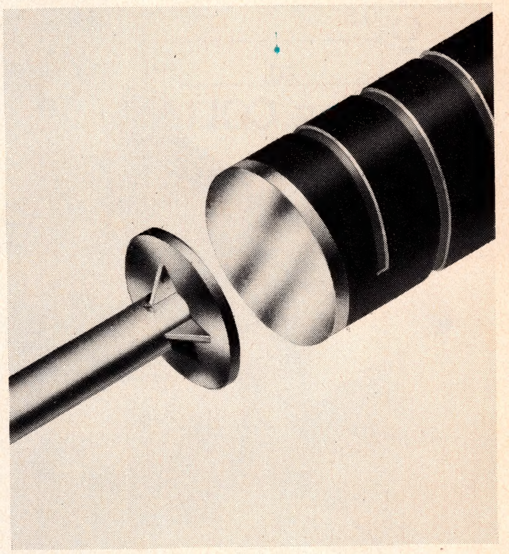


High Thermal Conductivity

A solid alumina substrate and other design features efficiently transfer heat from the resistor element. As an example, a ¼w unit at full load has a hot spot temp rise of only 30°C, half the rise experienced in some other types. Cooler operation means stability and reliability are optimized.



Capless Terminations

All Metal Glaze resistors have our exclusive high temperature soldered terminations. This capless construction means excellent pull strength and prevents substrate damage during assembly. With the additional protection of a molded jacket, 1/4w Metal Glaze resistors withstand a 20lb pull test.

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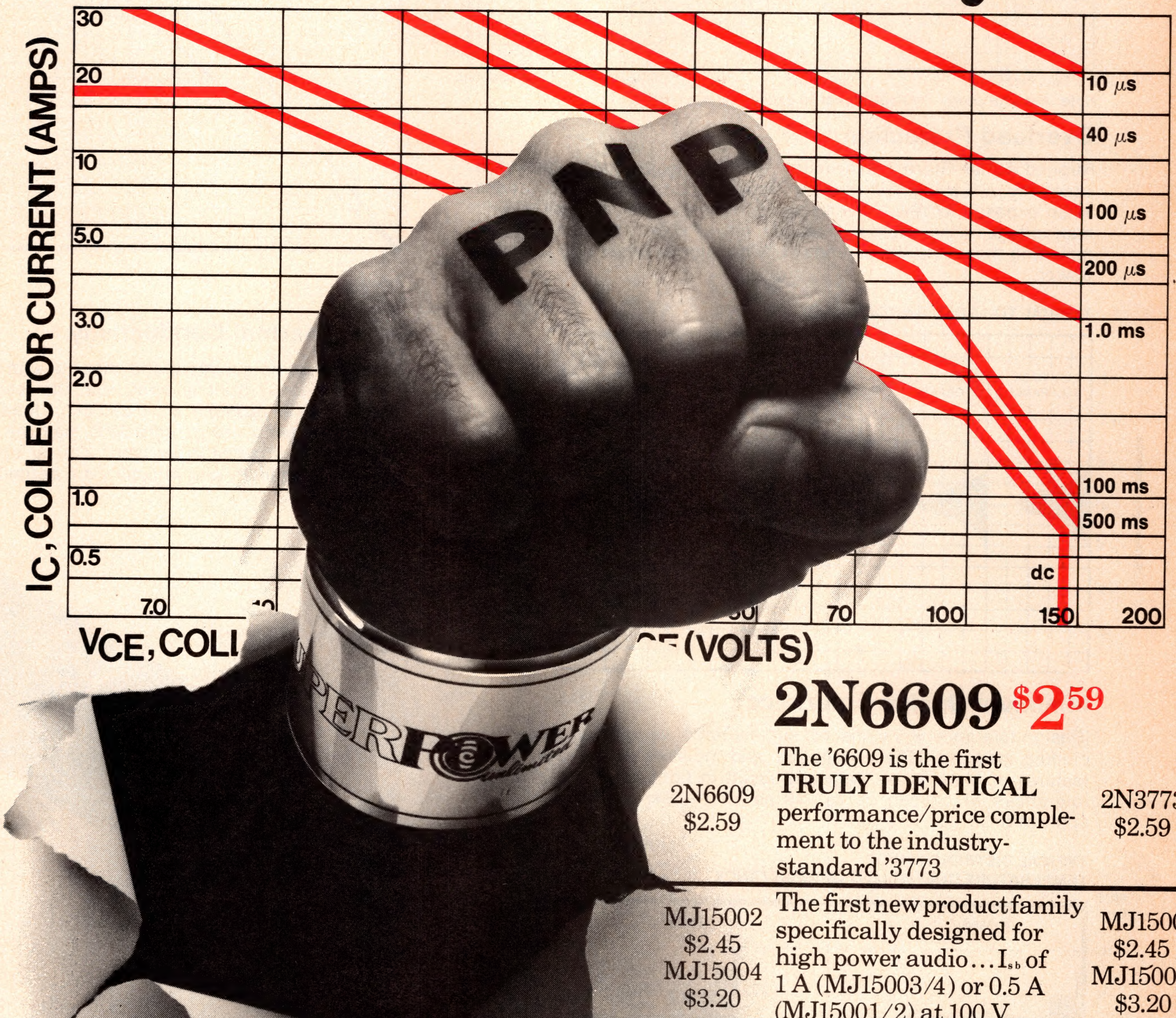

2N6609 $2.59

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MJ15002 $2.45 MJ15004 $3.20	The first new product family specifically designed for high power audio... I_{sb} of 1 A (MJ15003/4) or 0.5 A (MJ15001/2) at 100 V.	MJ15001 $2.45 MJ15003 $3.20
2N6594 65¢	A complementary pairing for cost-effective, 2N3055 replacement.	2N6569 65¢
MJ11011 $4.10 MJ11013 $4.60 MJ11015 $5.25	The first Darlington complements with... 1,000 min gain at 20 A... 60 to 120 V V_{CEO}...30 A I_C!	MJ11012 $4.10 MJ11014 $4.60 MJ11016 $5.25

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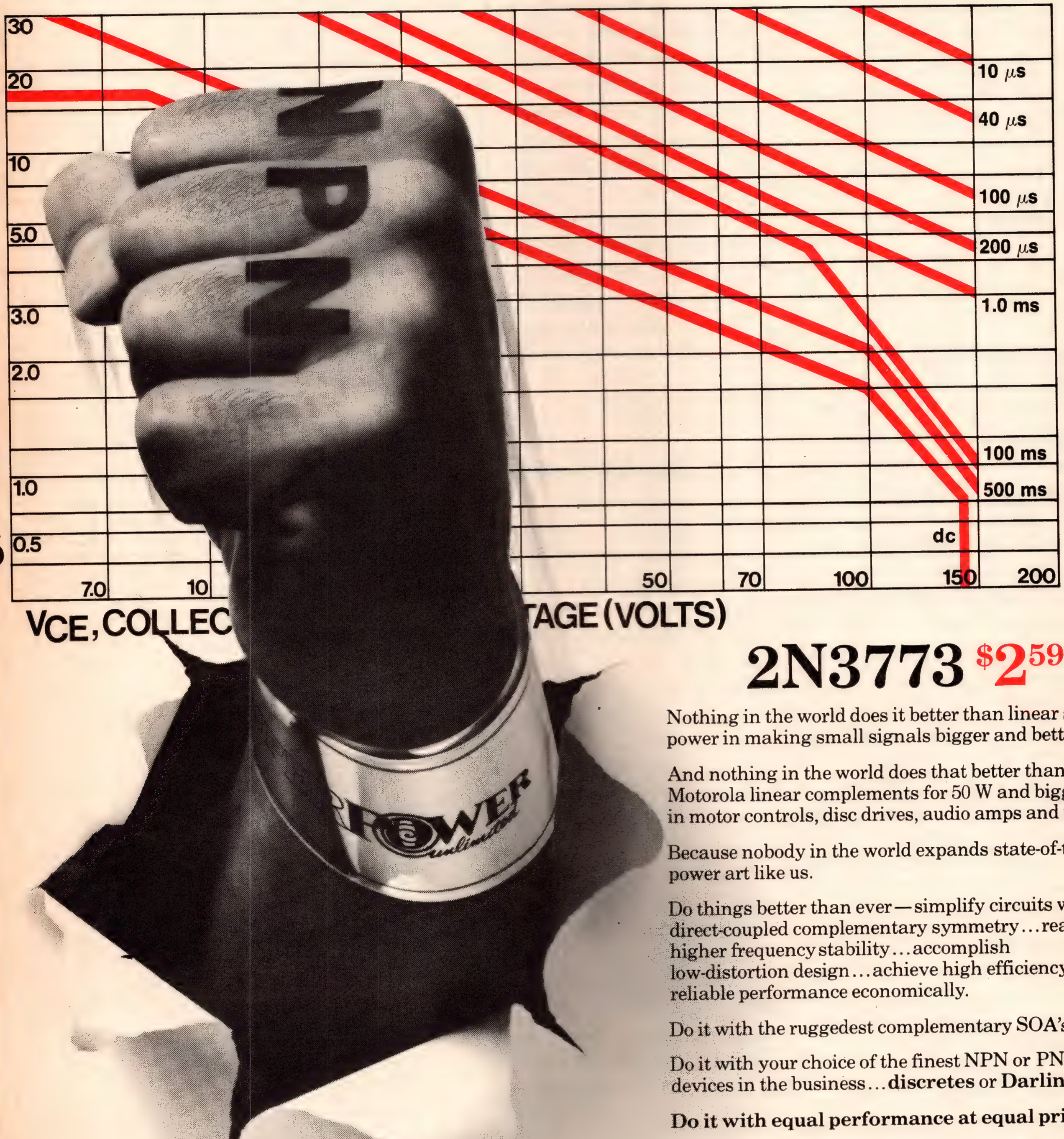

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SIGNALS and NOISE

Who needs the BET degree?

My August 5, 1976 editorial, which discussed the establishment of a formal qualification procedure for the practice of electronic engineering, generated a flood of reader responses. Obviously, my ideas are quite controversial, as evidenced by the following thought-provoking replies.

Walt Patstone
Editor

BET interested in design?

Dear Mr. Patstone,

Your editorial of August 5 contains a number of misleading statements. At the outset, if the surplus of qualified EE's truly exists, then they should be employable in preference to the engineering technologists. Salary data indicates that money's probably not at issue; the BET graduate is hired at comparable cost to the employer.

It seems incongruous to discuss on the one hand that engineering technologists "are definitely not as qualified as BSEE graduates to hold design-engineering positions," while dismissing any consideration of program content. BET curricula, for the most part, emphasize the design process. What is more important, the typical BET student is more interested in design than his BS counterpart. However, I doubt that industry needs any new hurdles to separate the men from the boys, such as the examination and license route. The creation of documents attesting to competency in specific skills is already provided in the Professional Engineer's Examination.

The real test of competency, as always, is on the job. There, many BS graduates sorely miss the laboratory and design courses that were eliminated to make room for more mathematical analysis. By the same token, BET graduates miss the analysis and basic science. However, both have had the same maturing process that earning an undergraduate degree provides; both have learned how to learn; and neither can blame success or failure on what happened in a classroom years or weeks ago.

The industry reaction to the BET appears to be (paraphrasing your last sentence) "If a BET is better qualified for a position than an EE, he'll get the job." In these days of "equal opportunity" and "affirmative action," can we justify acting otherwise?

William F. King
Andover, MA

A BS plus internship

Dear Mr. Patstone,

Your editorial does much to enlighten the practicing EE to the BET problem and "to prevent a dilution of our profession by sub-professionals." However, I disagree on one issue: A BSEE degree and nothing less should be a minimum requirement of acceptance as an engineer. Holders of BET degrees had their chance to enroll in an engineering curriculum—they chose not to! They are no more qualified to be even considered engineers than a baccalaureate in nursing is qualified to be a physician.

I believe that the minimum requirements to be considered an engineer should be a BS degree plus four years of engineering internship (i.e., documented engineering experience) and a P.E. license. Graduate degrees, the MS and PhD, should be treated as additional qualifications as they are for physicians.

Philip G. Dragonetti, P.E.
Largo, FL

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The Battle of the 80's continues:

With the introduction of Zilog's Z-80 microcomputer products the tide is turning in the battle for supremacy.

Features:	8080A	Z80-CPU	Features:	8080A	Z80-CPU
Power Supplies	+5,−5,+12	+5	Addressing Modes	7	11
Clock	2Φ,+12 Volt	1Φ,5 Volt	Working Registers	8	17
Standard Clock Speed	500 ns	DC to 400 ns	Static Operation	No	Yes
Interface	Requires 8222, 8228 & 8224	Requires no other logic and includes dynamic RAM Refresh	Non-maskable Interrupt	No	Yes
			Full TTL Compatibility	No	Yes
Interrupt	1 mode	3 modes: up to 6X faster	Throughput	Up to 5 times greater than the 8080A	
Instructions	78	158*	Program Memory	Generally 50% less than the 8080A	
OP Codes	244	696	*Including all of the 8080A's instructions.		

The Z-80 is a third generation LSI component set including CPU and I/O Controllers with full software support and second sourcing available now.

A single chip, N-channel processor arms you with a superset of 158 instructions that include all of the 8080A's 78 instructions with total software compatibility. The new instructions include 1, 4, 8 and 16-bit operations. That means less programming time, less program storage and less end costs. And you get memory-to-memory or memory-to-I/O block transfers, nine types of rotates and shifts, bit manipulation, a legion of addressing modes and a standard instruction speed of 1.6μsec. The Z-80 CPU and peripheral circuits require only a single 5V power supply and a single phase clock. With these circuits you can interface directly to a wide range of both parallel and serial interface peripherals and even dynamic memories without other external logic. With all these features you'll require approximately 50% less memory space for program storage and you'll get up to 500% more throughput than the 8080A.

The Zilog Batallion includes a development system with: Z-80 CPU Card with 4K Bytes of ROM/RAM Monitor software • 16K Bytes of RAM memory, expandable to 60K Bytes • Real Time Debug Module and In-Circuit Emulation Module • Dual Floppy Disc System • Software Package including Z-80 Assembler, Editor, Disc Operating System, File Maintenance and Debug.

We'll support this with resident microcomputer software, time sharing programs, software libraries and high-level languages such as PL/Z.

A reserve of reinforcements is ready. The Zilog Z-80 brings to the battlefront new levels of performance and ease of programming not available in second generation systems.

And while all the others busy themselves with overtaking the Z-80, we're busy on the next generation—continuing to demonstrate our pledge to stay a generation ahead.

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SIGNALS and NOISE

Controllable obsolescence

Dear Mr. Patstone,
What callous and efficacious snobbery you present in your August 5th editorial!

While I concede that a degree attests to a strong background in the basics of one's technical major, strengthens one's reasoning powers and aids in the development of "engineering curiosity," this does not necessarily assure that the end result will be a good design engineer.

Undergraduate courses are generally several years behind the state-of-the-art, which, in a rapidly changing area like electronics, is a lifetime. Even if the courses could be kept current, engineering obsolescence can occur within a year or two of graduation. This, I believe, is a controllable parameter. Even if one's employment provides only a narrow view of technology, there are available many journals, magazines (such as yours), continuing education programs or at-home hands-on experience if the initiative is exercised. Colleges provide a background or foundation; they do not provide a person with the necessary tools to develop producible, cost-effective designs—this comes from experience only.

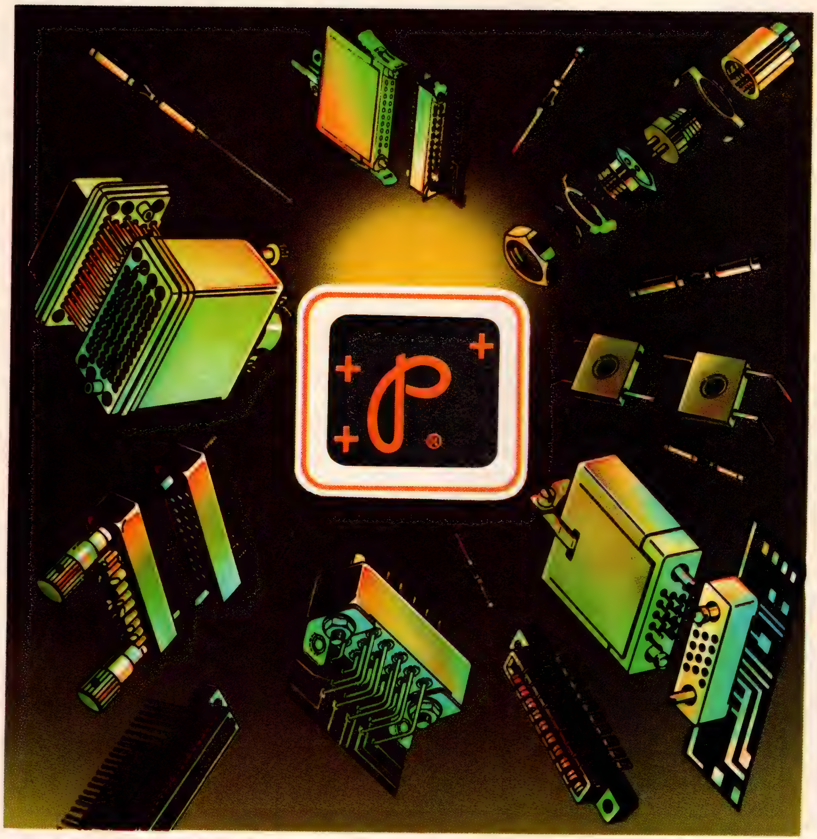
You attempt to raise engineers to a "super-professional" stature such as enjoyed by the AMA or ABA, but your tactics emerge more in tune with the closed shops of the unions. Personally, I would prefer to judge a man by his capability and not by his pedigree.

William T. Simonin
Senior Staff Engineer
Honeywell, Inc.
St. Petersburg, FL

"Both belong in industry."

Dear Mr. Patstone,
Regarding the "depth vs. breadth" controversy between BET and BSEE degrees, the whole discussion is a lot of BS anyway, (pardon the pun). The final result of either is the individual and his performance on the job. Too many in this profession hold a generally over-inflated view of a university graduate in both expectation and salary net worth. A graduate of a good BET program, on the other hand, has had a higher concentration of the practical applications of the state-of-the-art without the history, language or other nonapplicable studies required by universities for a BS. Both belong in the industry, and the decision as to which to hire should be the employer's.

Thomas W. Burnet
Woodstock, IL



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Problem
Interacting low-frequency filter adjustments.
Solution
HP's 3580A Spectrum Analyzer.
Benefit
Time saved, tuning simplified.

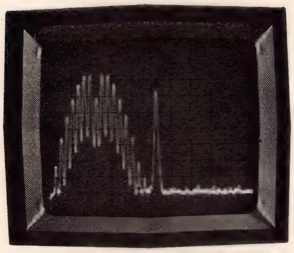
It's a typical problem. Your finished prototype usually contains multiple adjustments—which means you use a lot of time tuning your filter for top performance.

If you're designing filters to operate in the 5Hz to 50kHz range, you now can stop using so much time, stop being bothered by interactive adjustments. Our 3580A combines a built-in tracking oscillator, wide dynamic range, and digital storage to help speed and simplify every step of your next filter design. Follow this typical example and learn how the 3580A can help.

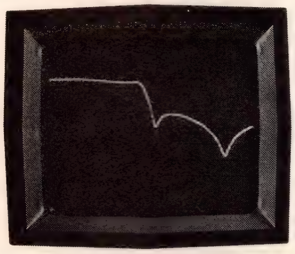
Step 1 With the 3580A, observe your spectrum and determine which frequency components to pass, which to attenuate. Decide the best type of filter to get the performance you need. Design your filter.

Step 2 Once you've selected your components and breadboarded a prototype, you can analyze your filter's performance with the 3580A. Its 80 db dynamic range gives you a clear view of everything taking place so you know exactly how your prototype is performing. Now with the tracking oscillator driving your filter, you can trim component values to optimize filter performance. Note how the tracking oscillator lets you observe the influence of each adjustment on filter performance—how it reduces the frustration you experienced before with interactive adjustments.

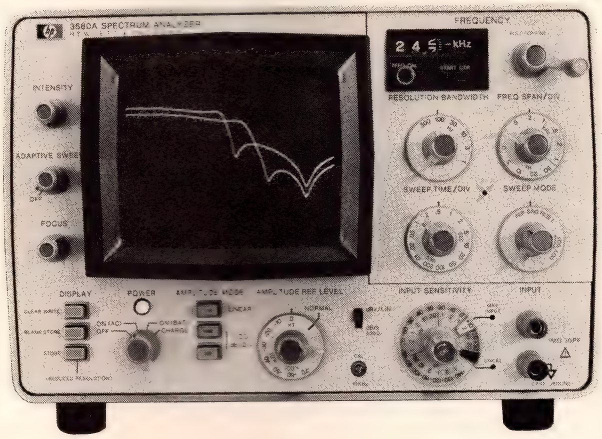
Step 1.
Analyze your spectrum.



Step 2.
Adjust your prototype's response.



Step 3.
Compare all production filters with the stored standard. Note the analog look that you get with HP's digital display.



Step 3 Package and build your first production filter. Use the 3580A's digital storage to superimpose both waveforms for simultaneous viewing—a big advantage of the 3580A. Now set up and store the response of a good production filter and simply compare other production units against the good one, making adjustments as needed.

All of the capabilities in one instrument gives you extra value in your filter design and production. It's priced at $4485*. Your local HP field engineer can give you all the details. Or write for our 8-page technical data sheet.

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SIGNALS and NOISE

A Marxist view?

Dear Mr. Patstone,

After decades of pressure-group warfare and pull-peddling in Washington, the Marxist view of government has now burst boldly into print in the pages of EDN magazine.

You and others propose that engineers should live up to the old collectivist attacks against capitalism by forcibly restraining competition from "outsiders"—engineering technologists. At a time when the IEEE is being denounced for academic elitism, one would expect the injustice of elitism in the profession as a whole to be denounced with equal fervor.

What is the nature of your argument? The editorial begins by asserting that BET programs are inferior in quality to BSEE programs. It concludes from this that mandatory licensing should exist. Forced discrimination against BET's requires some metaphysical basis, and this apparently is all you could find.

Sandwiched between the premise and the conclusion, as if to sever their link and discourage us from asking too many questions, a contradicting assertion declares that questions about the quality of BET programs are irrelevant. The editorial further dilutes its argument by condescending to let BET's enter the profession if they can "meet other screening requirements." It seems that BET's might be qualified for design work, after all.

The editorial is self-contradictory in yet another respect: If BET's weren't competent to do design work, there would be no incentive to restrain them. Incompetence cannot be perpetuated without precisely the protection from competitors that you advocate.

D.W. Johnson
Huntington Beach, CA

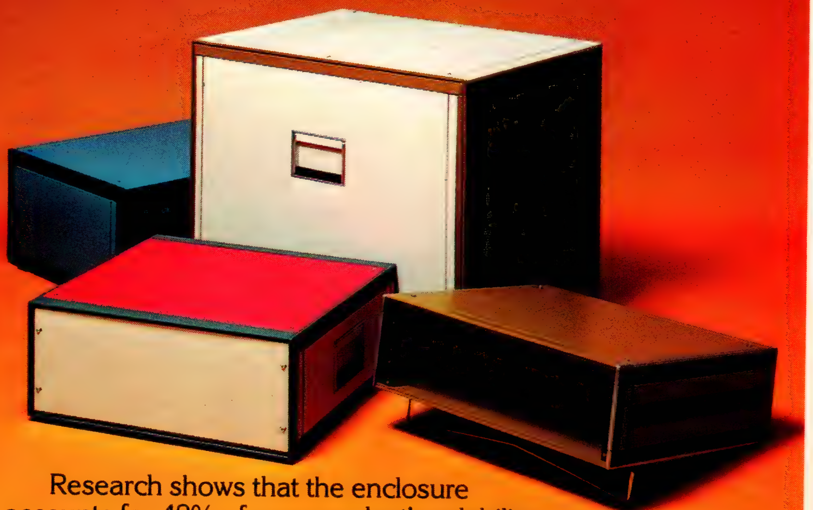
What is the true test?

Dear Mr. Patstone,

I have never noticed a correlation between a person's degree and his level of engineering competence. Many very good, intelligent designers do not have a sheepskin; yet there are any number of PhD's and BSEE's who don't seem to have a brain in their head!

Beyond that, while one can test for technical book learning, it's extremely difficult to test for good engineering judgement or ethics. What qualities should a design engineer have and how do you propose to test for them?

Robert A. Pease
San Francisco, CA



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SIGNALS and NOISE

"Let's not discriminate..."

Dear Mr. Patstone,

Your entire editorial carries the stench of "why don't we unionize to protect us professionals." Our industry and our country has thrived on free enterprise and the attitude of "let's quit talking about it and just get out and get the job done." Given time, the best qualified designer comes to the top. Let's not discriminate or incriminate because of race, creed, color, sex or title.

E. John Sutton
Sandia Laboratories
Albuquerque, NM

Qualification vs. protection

Dear Mr. Patstone,

Concerning your editorial, "Who Needs the BET Degree," are you concerned with qualifications or "protection" of jobs?

If in fact qualifications, be at peace. Who else but the qualified person will get and hold a job in any industry where survival depends on productivity (government agencies excluded)? If instead the concern is "protection" of jobs, what actually creates and sustains jobs if not productivity, again?

What of our industry's productivity (jobs) with your criteria "If a BET is better qualified for a nondesign position than an EE, he should get it"? Will our industry be more productive and secure if the best qualified are chosen only for nondesign positions? One of the best circuit designers I know has no formal EE education.

Nonproductivity- oriented, job-"protection" criteria have been widely used, of course. Witness Britain where they've "protected" themselves right out of jobs altogether.

Jerald Graeme
Manager, Monolithic Engineering
Burr-Brown
Tucson, AZ

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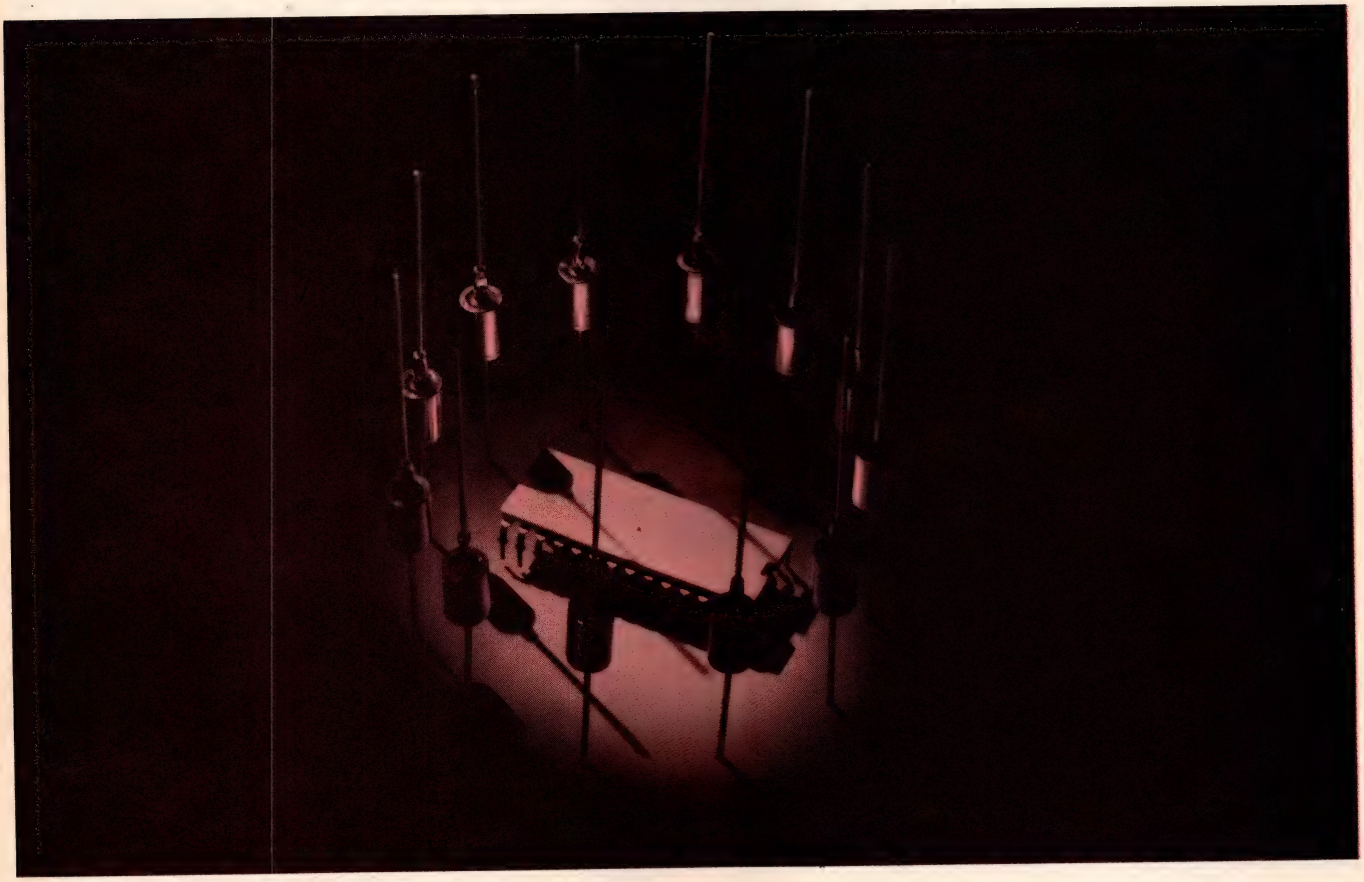

Line surges, lightning, relays, solonoids, motors and inductive loads, automobile ignition, static electricity, hash, noise . . . transients!

Microprocessing capabilities will take your next product design into new and hostile environments. How are you going to protect that expensive microprocessor circuit from damaging transients?

We have the answer: the new μP-Series TransZorb. Tailor-made for microprocessor circuits, μP-TransZorbs are available with voltage ratings from 5 Volts to 45 Volts.

Now you can provide maximum transient protection for your microprocessor and build-in unparalleled reliability. Field service calls are expensive, so it makes good sense to design-in transient protection from the very start; for $1.72* can you afford not to?

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Electrical system disturbances, such as static discharges, can result in transients exceeding 10,000 Volts. Placing μP-TransZorbs across Vss, Vdd, or Vcc lines and transient-prone data lines will maintain circuit voltages at nearly constant levels, even with surges in excess of one hundred amps. And TransZorb's response time is a blazing one picosecond!

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Get the whole picture:

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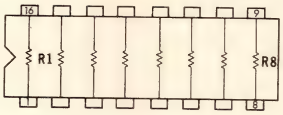

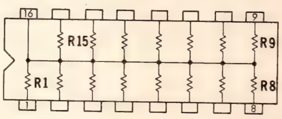

Get into the world of precision resistor networks. For more data, and applications information, contact your local distributor or Beckman Helipot today at (714) 871-4848, Extension 1776.

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EDITORIAL

The latest craze—Home Computing

Call it what you will—a craze, a fad, or a brief romance—home (or personal) computing is here and growing fast: Today numbers of manufacturers offer relatively low-cost microprocessor/microcomputer kits; hundreds of computer stores have sprung up throughout the country; computer-hobbyist magazines like BYTE and INTERFACE are being published; many computer clubs now exist; and a computer-hobbyist conference/exhibition has arrived on the scene (recently held in Atlantic City, NJ). Soon you'll be able to stop at your local computer store and purchase the computer program of your choice on cassette or some other low-cost recording medium.

So with all these tools available (including EDN, of course), anyone can learn the in's and out's of computing. And it can be a fun project at the same time.

How does all this relate to EDN's readers? Well, many hardware designers are working on projects right now who know that the best design solution should be a digital/μP/computer approach. Yet for numerous reasons that approach is not taken. In some instances, the designer feels he doesn't know enough about computers or programming; in others, his superiors are skeptical of the μP's importance, so they won't make the necessary investment.

Should it all end there? Absolutely not! I know lots of hardware types taking the hobbyist/home-computing route. Some have used what they learned to develop home projects and computer games; others have proved that the best solution for their work project is a computer approach and thus been able to convince their bosses.

For those of you who've read this far but are saying to yourselves, "Forsberg's possibly right but I don't have the money to find out for sure," here's the answer! Try attending a few computer-club meetings. It costs little more than your spare time; yet you'll probably find answers to most of your questions.

What happens at a computer-club meeting? Can you really get expert help if you become a computer hobbyist and run into a snag? Check John Conway's story about a typical computer-club meeting in our October 5 news section to find out.

Roy W. Forsberg

Roy Forsberg
Editorial Director

Requalification Advance Notice
Be sure to watch for November 5 EDN. If you wish to continue receiving EDN, you must complete the requalification card in that issue. Don't miss it!

Now, a single integrated circuit, our TAD-32 (Tapped Analog Delay), can provide filtering with passband-to-stopband ratios of 40 DB or more per device. Simple variation of the clock sampling rates over 5 decades will accordingly shift a given filter characteristic. Transversal or recursive filters can be constructed with over 60DB dynamic range and linear phase. Tapped delays up to several hundred milliseconds are possible.

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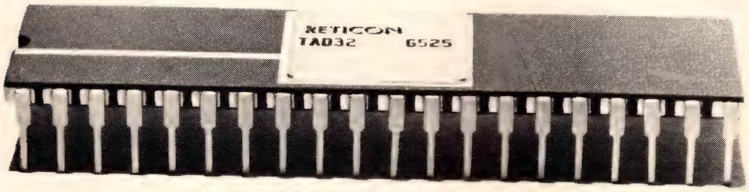

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Program it or modulate it . . .

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It puts the designer in complete charge.

This wide range of operation gives you unusual design flexibility. You can create simplified versions of present designs . . . or take unique approaches to new designs. You have linear gain over a 6-decade range to work with. A 50V/µs slew rate. Power levels adjustable from below 1 µW up to 30 mW. And if you need more than 1 mA output, the CA3094 has integral Darlingtons to provide 300 mA peak output.

In short, you can "shape" the variable op amp to fit the job—and create big circuit savings.

How much does all this flexibility cost? Amazingly little: 55¢ for the 3080E and 65¢ for the 3094E, at the 1K level.

For data sheets and application notes on these op amps, contact your local RCA representative. Or RCA.

Write: RCA Solid State. Box 3200, Somerville, N.J. 08876; Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste. Anne de Bellevue H9X 3L3, Canada; Fuji Building, Tokyo, Japan.

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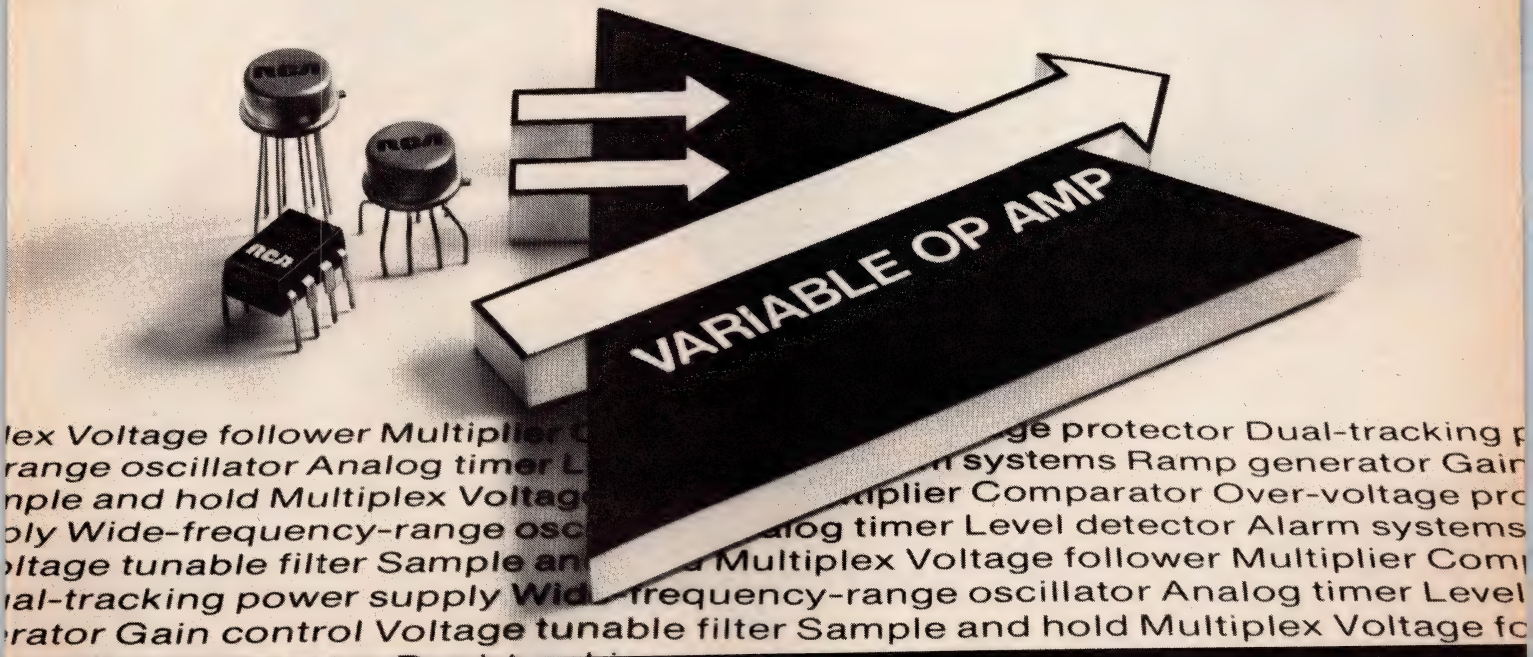
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Three computing calculators and plenty of peripherals: it's your choice. Three different models—the low-cost HP 9815, the powerful HP 9825 and the all-purpose HP 9830—offer a range of computing power.

HP peripherals include paper tape punch and readers, printers, storage devices, a digitizer, a CRT, and an X-Y plotter. You choose the model and I/O options to configure a system just right for you.

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The L5 Project: Can space colonies alleviate coming material shortages?

Paul Snigier, Associate Editor

Like a spider spinning a web from its entrails, the earth's first satellite colony will spread its glistening steel beams across the heavens, finally growing into a 19-mile long, 4-mile wide orbiting colossus—or large enough to support 10,000 people!

Meanwhile, bulldozers will mine the plains of the barren lunar surface, scooping up tons of lifeless moon dust and rocks which, after sintering into small blocks by the sun's heat, will be launched into space: Buckets racing down tracks will use the weak lunar gravity and lack of atmosphere to hurl over an 11-year period half a million tons of these blocks free from the moon's orbit.

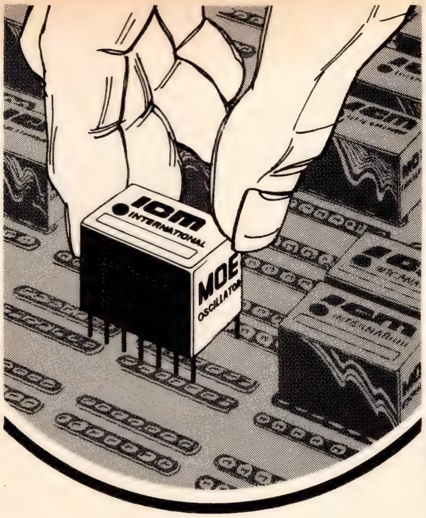
A quarter-million miles away back at the growing colony, this steady stream of lunar material—soil and atmosphere for a new world in space—will be trapped by a mass catcher and ferried toward the colony.

Space habitat or cosmic folly?

This bold proposal—which gained the serious and full support of at least one presidential candidate!—is presently under evaluation by NASA scientists from a cost-benefit analysis viewpoint; and if given the green light, the project could begin immediately.

Brainchild of Princeton University physicist Gerard K. O'Neill, this plan has a major economic advantage over all previous colony schemes: It is far more economical to use the matter and energy of space than to launch these metals and chemicals from earth.

For example, raw materials from the lunar surface (rich in aluminum, titanium and oxides),



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and later the asteroids (abounding in high-grade iron ore, nickel, carbon, nitrogen and hydrogen) will provide the materials, electricity, and even rocket fuel for the colonies.

To facilitate matters, all early colonies will orbit the L5 Lagrange liberation point—one of several areas within the moon-earth system with a balanced gravitational pull from both bodies. Thus, these colonies will need no energy to remain in orbit.

Islands under the sun

The first colony will be shaped like a toroid, cylinder or sphere; if a cylinder, the shell will consist of alternate sections of metal and glass running down its length.

Spun once every two minutes to create an artificial gravity, the colony will have one end-cap always pointing toward the sun. Slowly swinging open and shut, three aluminum mirror panels can then reflect sunlight into each mini-world, simulating a dawn-to-dusk 24-hour day-and-night cycle.

The land, covered with soil and forests, rivers and lakes, valleys and hills, will be dotted with homes and towns to create an earthlike topography to attract the many talented workers and their families needed to man the factories.

How will the lunar soil be enriched? Rocket shuttles from earth to the space sites will carry tanks of liquid ammonia and hydrogen, which can react with lunar oxides under solar heat to produce the mini-world's first water vapor. (Later colonies, however, will be self-sufficient, obtaining these chemicals from space.)

Agriculture for the L5 colonies will take place in external spheres and cylinders under various gravity conditions. Considering the unlimited, round-the-clock sunshine, nutrients and water, controlled crop production could shorten the growing season considerably.

Mining celestial metals

Why on earth would anyone want to start colonies in space? Perhaps because such a venture (though it will require substantial seed money to get the first colonies going) could prove the most profitable long-term investment ever envisioned.

To get some idea of the payoffs, consider a single asteroid retrieved by the colonies. That one asteroid, according to experts, will provide a 10 years' supply of iron ore for the earth's total needs! And the plentiful nickel could possibly be used for manufacturing rustproof ships, cars and structures.

In the face of our rapidly dwindling ores—which grow less rich each year and require ever more energy to mine and smelt—asteroid mining will provide a means of returning hundreds of billions of dollars of high-grade ore to earth.

Semiconductor factories in space?

Another payoff could result when zero-gravity semiconductor-manufacturing technology becomes an inexpensive process. It was long suspected (and finally proved in the Skylab experiments) that semiconductor crystals and other materials achieve degrees of purification in space not easily attainable on earth.

As an added bonus, the colonies could possibly manufacture large solar panels. If so, sunsatellites measuring dozens of square miles could be more economically manufactured in space than on earth. After placement in synchronous orbit these sunsatellites could convert solar energy to electricity and finally to microwave beams directed to earth stations. The received beams, converted into electricity by large "rectenna"

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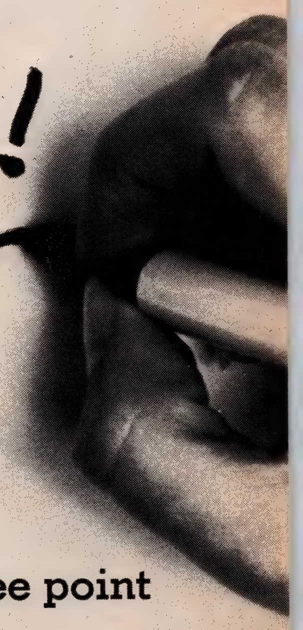

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dipole farms (a concept recently proved feasible by Raytheon and Arthur D. Little, Inc.), would be used for homes and industry.

Other potential by-products include pure pharmaceuticals inexpensively produced using electric fields under low gravity conditions. When manufactured on earth, such products cost a billion dollars per pound!

Furthermore, movement of factory machinery and structure assembly will take on a new dimension, since simulated gravity can be "turned" on or off at will, making cranes and other equipment unnecessary.

The growing frontier

Each colony will create a beachhead from which new colonies can emerge: After reaching the "critical size," the colonies will become self-sustaining and then multiplying entities, feeding upon the metals and chemicals of the moon and asteroids as well as the solar energy of space. □

Fourth-generation µP's combine multiple functions on a single chip

Russell Fish, µP Consultant, Austin, TX

With much intelligent logic scheduled for design into low-cost products, semiconductor manufacturers have reevaluated their microprocessor philosophies. Since inexpensive consumer-oriented items require very little peripheral memory, the chip builders now realize that, first, the processors themselves must make a profit; and second, CPU complexity and density must be such that CPU, I/O and memory can fit

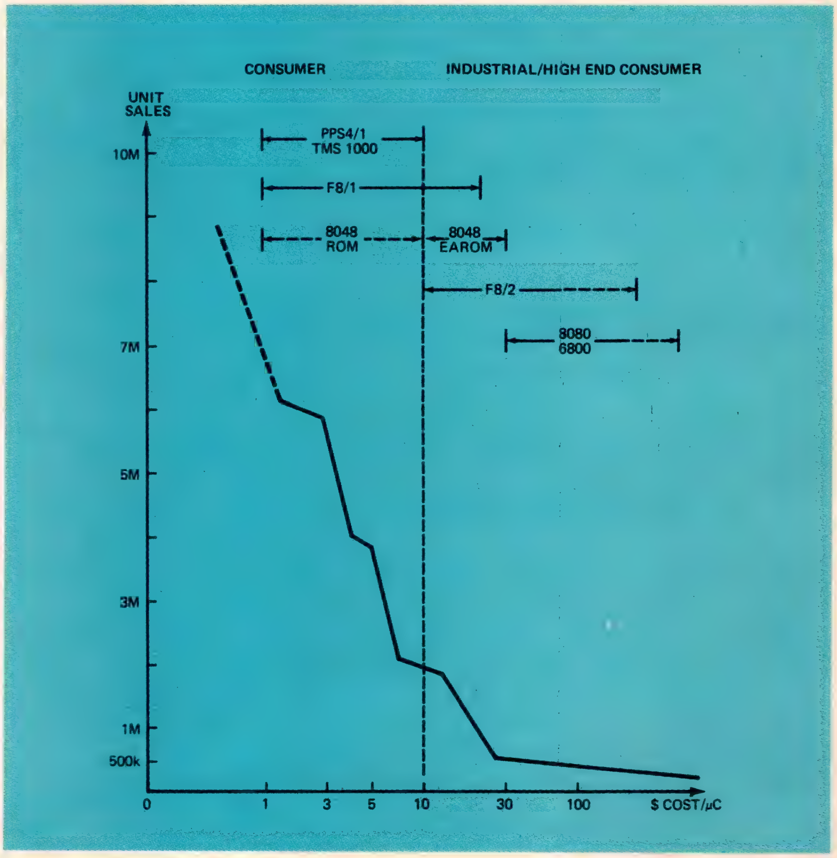

Fig. 1—The µC marketplace in 1978? Perhaps! Volume sales of low-cost "all in one and one for all" µP's could put a "bug" in almost every electronic consumer product.

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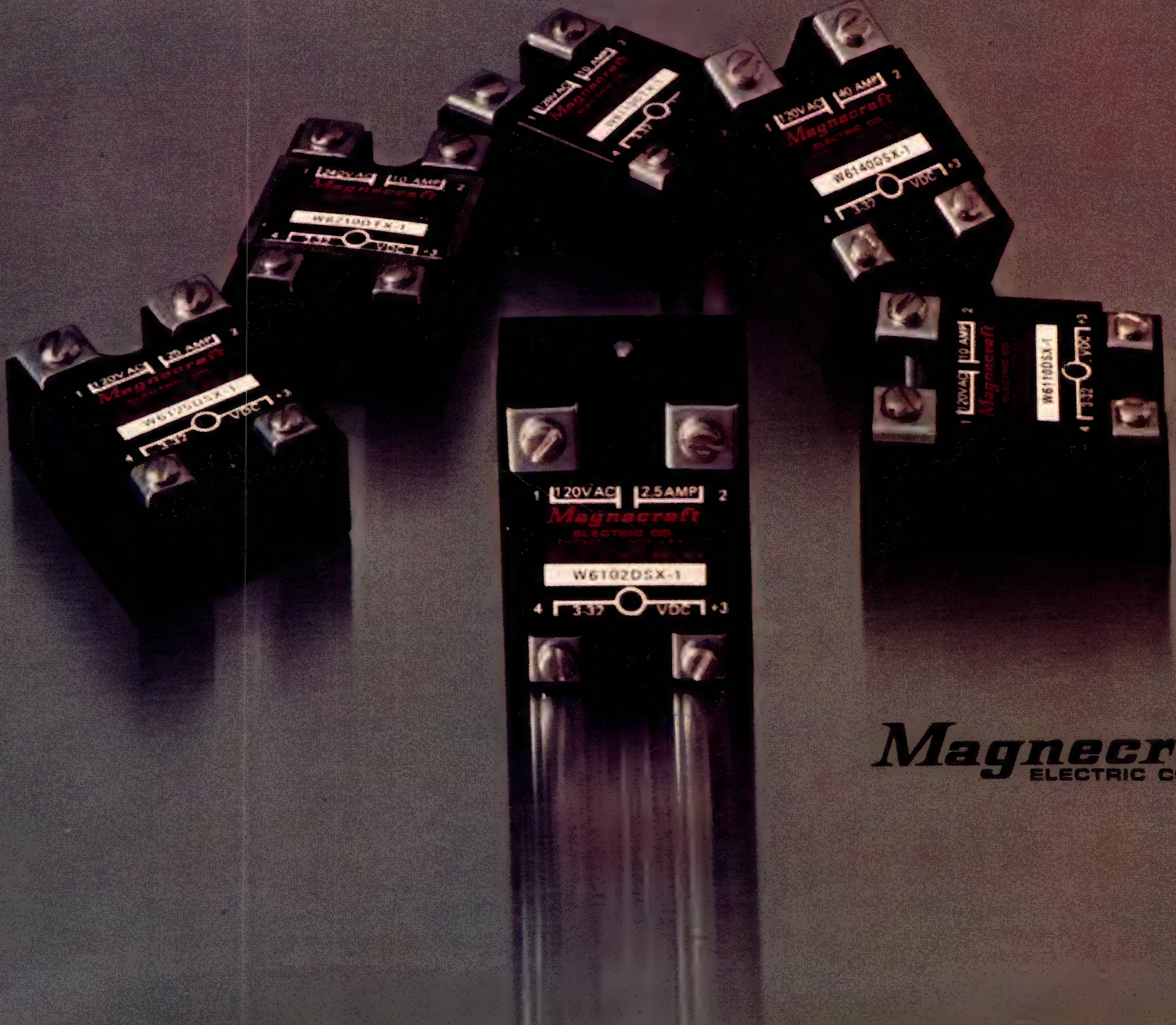

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into as few chips as possible.

The solution?

The projection in **Fig. 1** illustrates that enough volume for the under-\$10 μP exists for semi-houses to realize profits on chips alone.

One chart worth 1000 words

Derived by compiling existing low-end control applications and taking educated guesses at the penetration microprocessors can achieve for a given cost, **Fig. 1** plots volume vs. cost.

Typical applications considered in its construction include automobiles, washers, dryers, gas pumps, copiers, and vending machines. Several breakpoints are shown on the curve, but the two most important ones occur at three and five dollars. As microcomputer costs approach five dollars from the high side, parts begin to appear in "top-of-the-line" products for many applications. Examples of this phenomenon are the "Chrysler Lean Burn" and the "Amana Radar Range."

For many applications, when the price reaches five dollars, microcomputers can be included in the standard line of products, and volume increases dramatically. For other applications, a similar effect occurs at three dollars.

The three- and five-dollar prices are often mentioned by designers. Apparently, at these points engineers find that μP's can replace existing mechanical controls. The breakpoint around one dollar anticipates the development of another high-volume commodity similar to present-day watches and calculators. Also around a dollar, cameras, table radios, and small appliances become fair game for microcomputer control.

New animals in the menagerie

What new μP devices can we expect?

The MM5734 is National Semiconductor's entry into low-end controllers. Internally, it has a classic calculator architecture. The instruction set contains the basic bit-manipulation and arithmetic instructions. MM5734 is the only present low-end microcomputer that directly drives LED displays.

Rockwell's MM76 is basically a PPS-4/1 with less ROM and RAM. Both Rockwell parts are strong on bit manipulation, having "SET," "RESET," and "SKIP-IF-SET" instructions for both I/O ports and memory. The clock requires only an external resistor rather than both a resistor and capacitor. While not possessing true interrupt capability, the PPS-4/1 has two input lines that can set flip-flops (testable by true interrupt handling); while the latches aid in recognizing that a fast real-time signal has occurred.

PPS-4/1 I/O capability easily expands by using the serial-I/O port with an external shift register and latch. For action that takes place in slow real time, this type of I/O proves very efficient. Most appliance-control signals can be implemented through the serial-I/O port-expansion concept, and two levels of subroutine nesting can be saved in the on-chip push-down stack.

The availability of several multifunction instructions reduces program size. These instructions can serve in loops such as those that perform multiple-precision arithmetic. One instruction can do a function and then, if the loop is finished, fall out if it flags true.

"Big news from Big D"

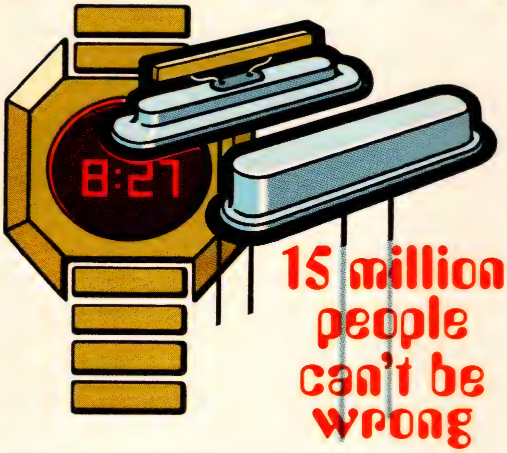
The Texas Instrument TMS-1300 is a TMS-1000 with twice as much RAM and ROM. The TMS-1000 family makes extremely efficient use of control memory by having only single-byte instructions. The part has bit-manipulation capabilities similar to the PPS-4/1 and saves one level of subroutine nesting; the accumulator can output directly to I/O port, or an on-chip decoder can generate the appropriate 7-segment digit.

Because a PLA decodes TMS-1000 instructions, this model is one of the few microprogrammable μP's. Users can microcode special instructions when programming the ROM mask.

The 1650 from General Instru-

MICROCOMPUTER	MANUFACTURER	PROCESS	INSTRUCTION EXECUTION	SUPPLIES	RAM	ROM	I/O	ALU	10k	100k
MM5734	NATIONAL	PMOS	14 μSEC	+9V	55 x 4	630 x 8	22	4-BIT		
MM76	ROCKWELL	PMOS	12.5 μSEC	+15V	48 x 4	850 x 8	31	4-BIT	$5	$3
TMS 1000	TI	PMOS	15 μSEC	+15V	64 x 4	1024 x 8	23	4-BIT	$5	$3
PPS-4/1	ROCKWELL	PMOS	12.5 μSEC	+15V	96 x 4	1344 x 4	26+ SERIAL	4-BIT	$7	$5
TMS 1300	TI	PMOS	15 μSEC	+15V	128 x 4	2048 x 8	28	4-BIT	$7	$5
1650	GENERAL INSTRUMENT	NMOS	1 μSEC	+5V	32 x 8	512 x 12	24	8-BIT	$10	$5
F8/1	FAIRCHILD	NMOS	1.5 μSEC	+12V, +5V	64 x 8	1024 x 8	32	8-BIT	$12	< $10
8048	INTEL	NMOS	–	+25V, +5V	64 x 8	1024 x 8 (EAROM)	28	8-BIT	$12	$10
6700/50	MOTOROLA	NMOS	2 μSEC	+25V, +5V	64 x 8	1024 x 8 (EAROM)	SERIAL/ 24	8-BIT	$12	$10
F8/2	FAIRCHILD/ MOSTEK	NMOS	2 μSEC	+12V, +5V	64 x 8	1024 x 8	32	8-BIT	$13	$11
6505/6530	MOS TECHNOLOGY	NMOS	2 μSEC	+5V	64 x 8	1024 x 8	16	8-BIT	$10	< $7
1872	WESTERN DIGITAL	?	?	?	?	?	?	?	?	?

Fig. 2—Low-end μP's currently available (or soon to be) mock their "big brothers" and put CPU, I/O and memory onto a single chip (or two).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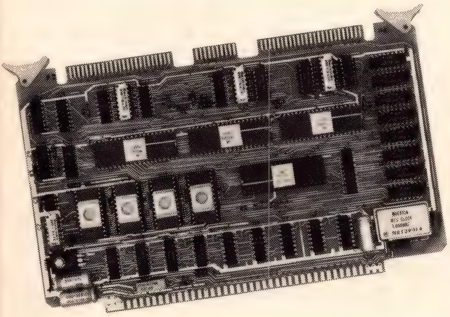

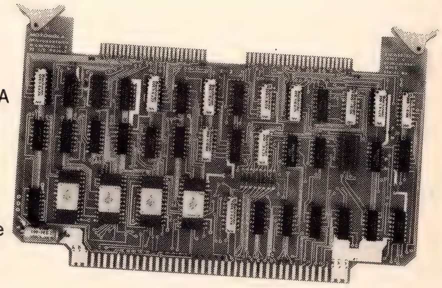

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M68MM09	CMOS/RAM Battery Module
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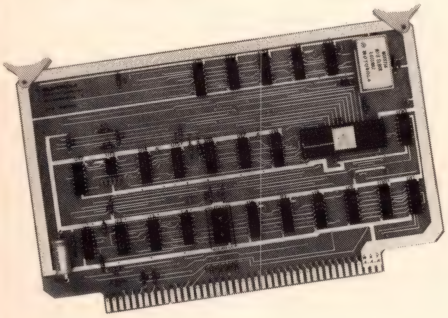

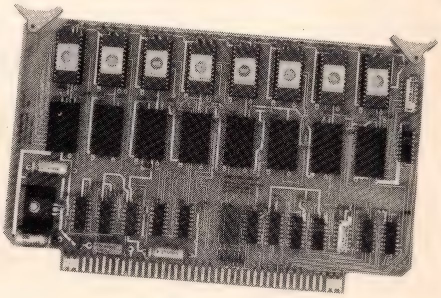

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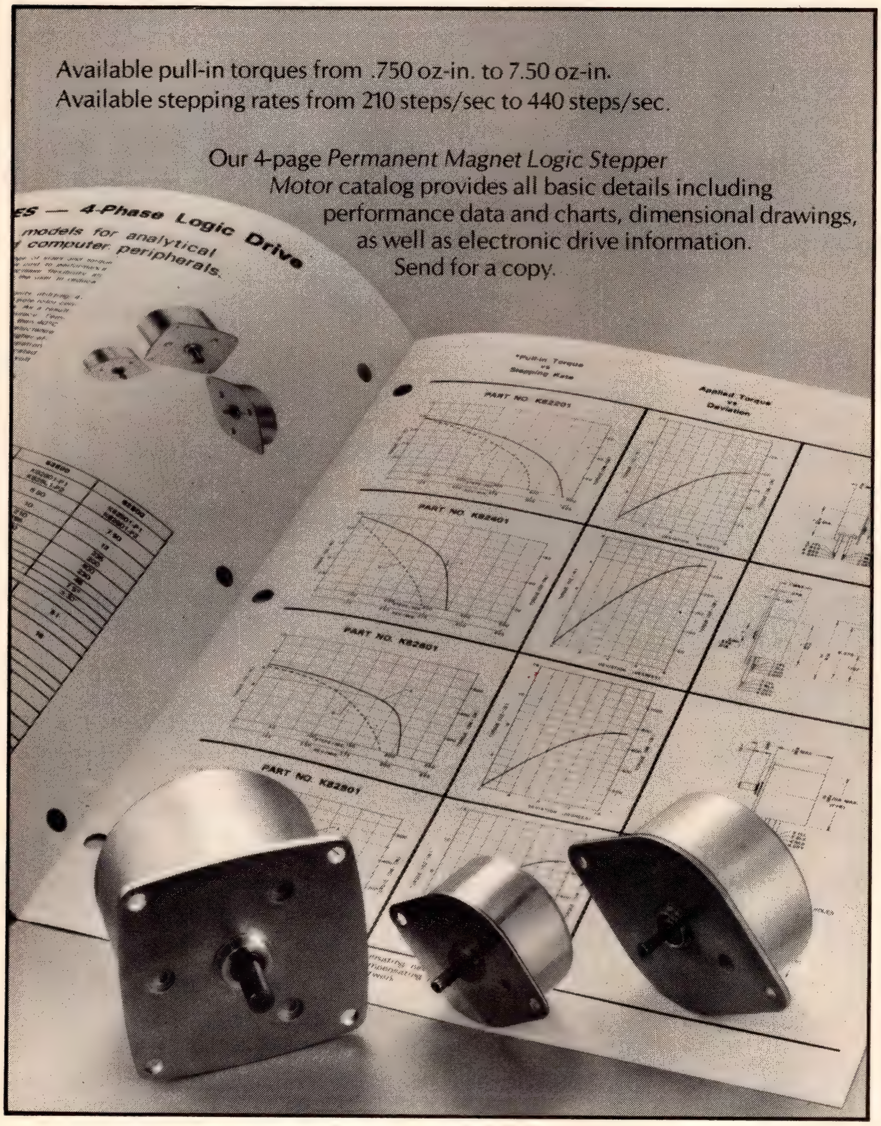

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ments, one of the fastest MOS microprocessors around, is the only low-end microcomputer to have minicomputer-type access to its register stack. This power doesn't come free as the instruction word is 12 bits wide. But the 1650 does have interrupt capability and a real-time clock input. It saves two levels of subroutine nesting. The instruction set is strong in bit and logic operations.

Like three peas in a pod

Fairchild's F8/1 is the non-expandable single-chip version of the 2-chip F8/2. The F8 instruction set features both binary and BCD math, logical operations, and many conditional branches. It saves two levels of nesting. The chip has interrupt capability and an interval timer (thanks to a polynomial shift register).

Both the Intel 8048 and Motorola 6700 supposedly imitate the F8/1, but Intel and Motorola also offer a version with serial I/O.

By adding a combination RAM/ROM, I/O, interval-timer chip to their existing CPU, MOS Technology succeeded in producing a 2-chip microcomputer. The 6500's addressing modes make it probably the most powerful MOS microprocessor around for large systems, but the intelligent I/O and interval timer on the combination chip provide for a good small control system.

The 6505/6530 has all the powerful instructions and addressing modes needed for a general-purpose system, but the general-purpose power and attendant overhead place this MOS Technology unit at the high extremity of the low-end microcomputer world.

For your convenience, we've tabulated the "lot" of new (and expected) processors into a small chart **(Fig. 2)**. □

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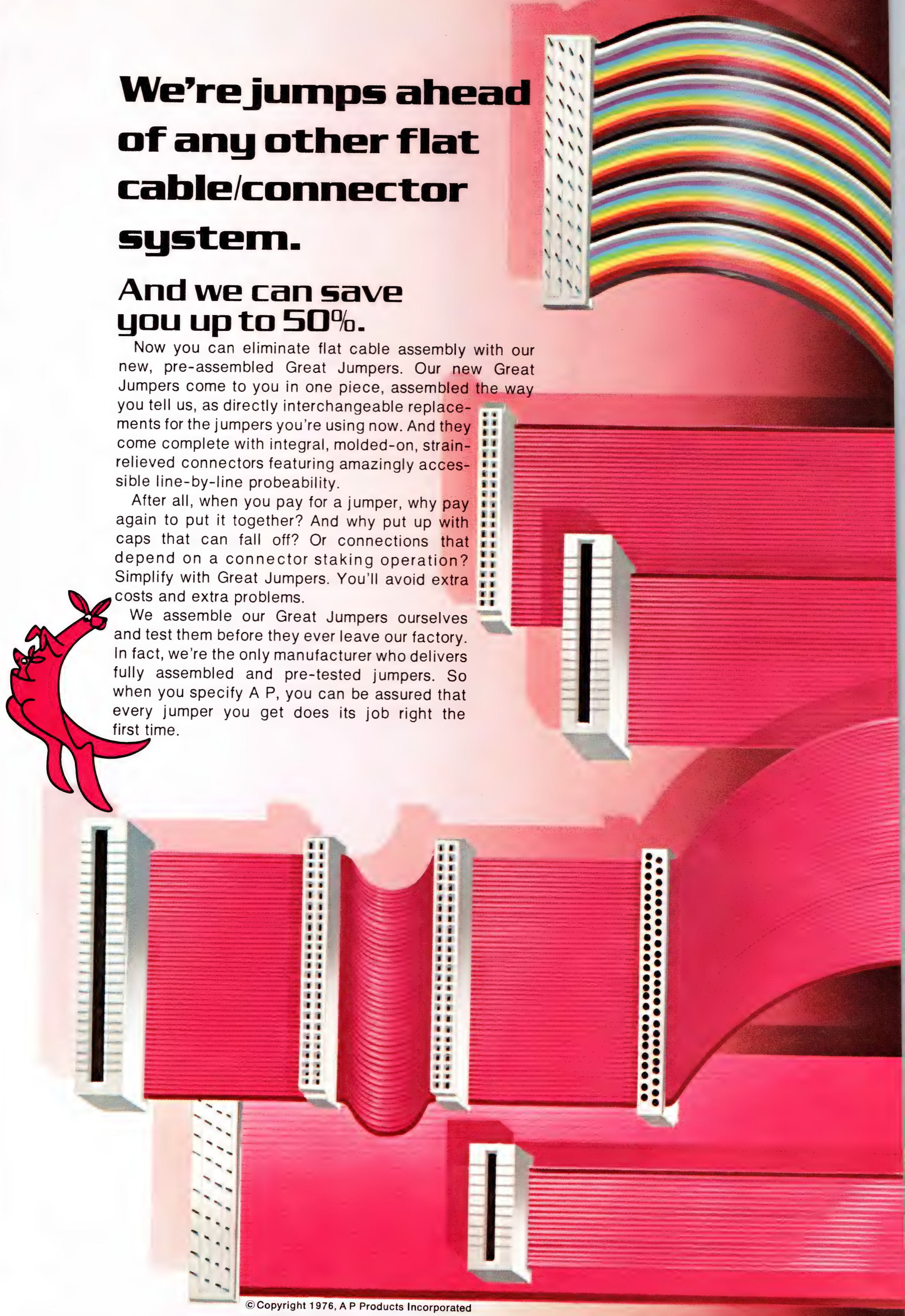
Now you can eliminate flat cable assembly with our new, pre-assembled Great Jumpers. Our new Great Jumpers come to you in one piece, assembled the way you tell us, as directly interchangeable replacements for the jumpers you're using now. And they come complete with integral, molded-on, strain-relieved connectors featuring amazingly accessible line-by-line probeability.

After all, when you pay for a jumper, why pay again to put it together? And why put up with caps that can fall off? Or connections that depend on a connector staking operation? Simplify with Great Jumpers. You'll avoid extra costs and extra problems.

We assemble our Great Jumpers ourselves and test them before they ever leave our factory. In fact, we're the only manufacturer who delivers fully assembled and pre-tested jumpers. So when you specify A P, you can be assured that every jumper you get does its job right the first time.



©Copyright 1976, A P Products Incorporated

We can make any jump in any of 360 ways.

And there are more ways to come soon.

Our Great Jumpers are available with three basic end terminations: Socket connectors, printed circuit board connectors, or card-edge connectors. Each of these termination types is available with any of the five most used flat cable widths: 20, 26, 34, 40 and 50 conductor. And Great Jumpers are available single-ended, or double-ended to your requirements, using any mix of end termination types and sizes.

Tell us about the Great Jumpers you need and watch us hop to it.

We make Great Daisy Jumpers,™ too.

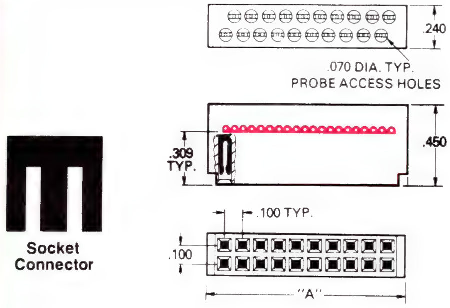
Design any kind of daisy chain arrangement you can think of around our Great Jumpers and we can deliver it fully assembled, tested and ready-to-use. Contact your A P rep for details.

And there's more.

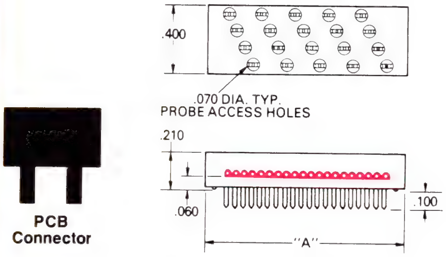
Patent pending.

Second, choose your connectors.

Left Connector	Top View	Side View	Right Connector	Contacts Left	Contacts Right	Style Code
Left Connector (Socket)	**Stripe Up**		None	Down	N/A	922501
			Socket	Down	Down	922521
			PCB	Down	Down	922522
			Card-Edge	Down	Down	922523
			Socket	Down	Up	922531
			PCB	Down	Up	922532
			Card-Edge	Down	Up	922533
	Stripe Down		None	Down	N/A	922511
			Socket	Down	Up	922541
			PCB	Down	Up	922542
			Card-Edge	Down	Up	922543
Left Connector (PCB)	**Stripe Up**		None	Down	N/A	922502
			Socket	Down	Down	922526
			PCB	Down	Down	922524
			Card-Edge	Down	Down	922525
			Socket	Down	Up	922536
			PCB	Down	Up	922534
			Card-Edge	Down	Up	922535
	Stripe Down		None	Down	N/A	922512
			PCB	Down	Up	922544
			Card-Edge	Down	Up	922545
			Socket	Down	Up	922546
Left Connector (Card-Edge)	**Stripe Up**		None	Down	N/A	922503
			Socket	Down	Down	922528
			PCB	Down	Down	922529
			Card-Edge	Down	Down	922527
			Socket	Down	Up	922538
			PCB	Down	Up	922539
			Card-Edge	Down	Up	922537
	Stripe Down		None	Down	N/A	922513
			Card-Edge	Down	Up	922547
			Socket	Down	Up	922548
			PCB	Down	Up	922549

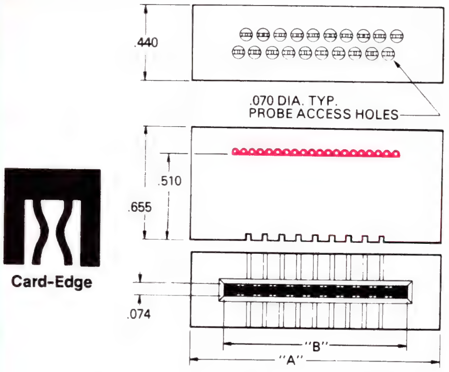


No. Contacts	Dim. "A"
20	1.160
26	1.460
34	1.860
40	2.160
50	2.660



No. Contacts	Dim. "A"
20	1.200
26	1.500
34	1.900
40	2.200
50	2.700

Request Bulletin 7.04 for PC board drill patterns.

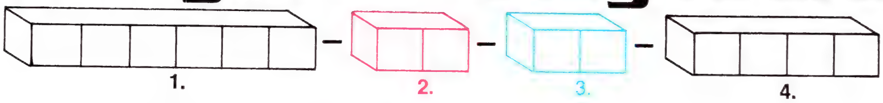


No. Contacts	Dim. "A"	Dim. "B"
20	1.500	1.100
26	1.800	1.400
34	2.200	1.800
40	2.500	2.100
50	2.980	2.600

Request Bulletin 7.04 for PC card dimensions.

Dielectric: UL recognized glass-filled polyester. Non-corrosive contacts: Socket connector and card-edge connector, alloy 770; PCB connector, alloy 725. All dimensions in inches.

Now you're ready to order.



1. Enter 6-digit style code (see chart)

2. Indicate whether 20, 26, 34, 40 or 50 contacts in connector

3. Enter "01" for Electric pink solid conductor cable.
   Enter "02" for Electric pink stranded conductor cable.
   Enter "99" for rainbow stranded conductor cable. (Available on single-ended jumpers only)

4. Enter tip to tip length in inches.
   ± ⅛ inch tolerance for jumpers up to 12"
   ± ¼ inch for jumpers over 12" and under 36"
   ± ½ inch if longer than 36"

Your first Great Jumper is free. Just tell us which.

Most offers end with "Here's how to order." But that's where ours is just getting off the ground.

Your local A P Products factory rep (he's listed on the back page) will deliver an evaluation sample of one of our new Great Jumpers free. Made to order, just the way you tell us you want it. Just follow these charts, make your choices and give him a call.

The sooner you tell us how you want your free jumper, the sooner we can get hopping.

First, decide on a ribbon.

Great Jumpers feature laminated PVC insulated ribbon cable that's made to take its lumps as it makes its jumps. The rigors of real-world system performance are met and exceeded in our design. Conductors are No. 28 AWG. The insulation and lamination are designed for quick, easy tear-down and separation without need for a cutting tool. And they're available three ways.

ELECTRIC PINK SOLID CONDUCTOR RIBBON CABLE.

Our most economical. A solid edge stripe helps identify cable orientation.

ELECTRIC PINK STRANDED CONDUCTOR RIBBON CABLE.

Perfect for applications demanding repeated flexing. And cable orientation is identified with an edge stripe.

OPTIONAL RAINBOW CABLE WITH STANDARD COLOR CODING.

Available only on single-ended jumpers, designed for applications where each conductor must be discretely connected. Conductors are No. 28 AWG stranded with standard color coded insulation. And groups of ten conductors are color stripe coded on the back of each cable for easy identification of wire number and wire group.

Listed by UL under subject 758, style 2480 or 2651.

A P GREAT JUMPERS FLAT RIBBON CABLES ALWAYS COME FULLY ASSEMBLED, TESTED AND READY-TO-USE.

Get your first Great Jumper free from your A P Products rep.

He'll have you hopping happy when you hear how little your next ones will cost.

Remember . . . fully assembled and tested A P Great Jumpers can cost just about half as much as competitive jumpers. In fact, if you allow for the cost of assembling and testing other jumpers, Great Jumpers can cost you even less.

So look up your local A P rep. And connect with him. For happier endings. By leaps and bounds.

ARIZONA
Piper-Goyne, Incorporated
P.O. Box 1648
4261 North Brown Avenue
Scottsdale, AR 85252
Phone: (602) 946-4437
(602) 949-8424
TWX: 910-950-0083

CALIFORNIA
Brooks Technical Group
2465 East Bayshore, Suite 345
Palo Alto, CA 94303
Phone: (415) 328-3232
TWX: 910-373-1198

Daniels & Doty Sales Co.
5575 Magnatron Blvd. Suite B
San Diego, CA 92111
Phone: (714) 560-6266

Mission Marketing Group
2182 Dupont, Suit 209
P.O. Box 17477
Irvine, CA 92713
Phone: (714) 833-1802

COLORADO
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8041 West I-70
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Denver, CO 80002
Phone: (303) 420-4646
TWX: 910-938-0755

CONNECTICUT
Tri-Com Associates
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Washington, CT 06793
Phone: (203) 868-7748

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Phone: (305) 894-3351
TWX: 810-850-0125

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Des Plaines, IL 60018
Phone: (312) 298-4830
TWX: 910-233-5980

INDIANA
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Fort Wayne, IN 46806
Phone: (219) 447-9623

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Compar Chesapeake, Inc.
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Phone: (301) 484-5400
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Tri-Com Associates
Box 172
Burlington, MA 01803
Phone: (617) 272-8163

MICHIGAN
Norm Case Associates, Inc.
P.O. Box 103
Milford, MI 48042
Phone: (313) 356-2161

MINNESOTA
Charles E. Bohlig Associates
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Minneapolis, MN 55104
Phone: (612) 922-7011
TWX: 910-576-3429

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P.O. Box 24552
226 Chamonix Court
St. Louis, MO 63141
Phone: (314) 434-6242
(Also)
12825 Bristol
P.O. Box 144
Grandview, MO 64030
Phone: (816) 765-2998

NEW JERSEY
Compar New York, Inc.
404 Clifton Avenue
Clifton, NJ 07011
Phone: (201) 546-3660
TWX: 710-989-7239

Sunday-O'Brien, Inc.
15 Potter Street
Haddonfield, NJ 08033
Phone: NJ (609) 429-4013
Phone: PA (215) 923-5195
TWX: 710-896-0679

NEW MEXICO
Piper-Goyne Incorporated
11701 Menual NE
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Albuquerque, NM 87111
Phone: (505) 294-1436

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Compar New York, Inc.
404 Clifton Avenue
Clifton, NJ 07011
Phone: (201) 546-3660
TWX: 710-989-7239

NEW YORK (Upstate)
Nycom, Incorporated
2002 Teall Avenue
Syracuse, NY 03206
Phone:(315) 437-8343
TWX: 710-541-1506

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Norm Case Associates, Inc.
P.O. Box 4791
Fairview Park, OH 44126
Phone: (216) 333-4120
TWX: 810-421-8396
(Also)
P.O. Box 217
Centerville, OH 45459
Phone: (513) 433-0966

OREGON
Freed Associates
2953 NW Imperial Terrace
Portland, OR 97210
Phone: (503) 223-3374

TEXAS
Allied Components, Inc.
Suite 730, Keystone Park
13771 N. Central Expressway
P.O. Box 31027
Dallas, TX 75243
Phone: (214) 238-0408
TWX: 910-867-4783
(Also)
4615 North Freeway, Suite 305
Houston, TX 77022
Phone: (713) 691-3961
TWX: 910-881-3741
(Also)
P.O. Box 14274
Austin, TX 78761
Phone: (512) 443-9687

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Freed Associates
11031 118th Place NE
Kirkland, WA 98033
Phone: (206) 822-8223

WISCONSIN
Coombs Associates, Inc.
6663 Industrial Loop
Greendale, WI 53129
Phone: (414) 421-2300

CANADA
Weber Electronics, Inc.
1111 Finch Ave. W.
Downsview, Ontario
M3J2E5
Phone: (416) 638-1322

A P PRODUCTS INCORPORATED
Box 110-Q • 72 Corwin Drive • Painesville, Ohio 44077
Tel: 216/354-2101 • Twx: 810-425-2250

Electronic Component

Leadtime Index

OCTOBER, 1976

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
CAPACITORS			
Ceramic	6	12	▲
Electrolytic			
aluminum	6	12	▲
tantalum	6	11	▲
Film			
metal case	5	9	▼
non-metal case	5	9	▼
Mica	4	8	▼
Paper	5	10	▲
Trimming	5	9	▲
CONNECTORS			
Coaxial	5	10	▲
Multipin circular			
high-density	6	11	▼
standard	5	10	▲
Printed circuit	5	9	▲
Rack & panel	5	9	▲
FANS & BLOWERS	8	13	▲
FRACTIONAL H.P. MOTORS	13	21	▲
INTEGRATED CIRCUITS			
DTL	6	10	▲
ECL	6	10	▲
TTL	4	7	▼
MOS	5	7	▼
CMOS	5	8	▼
Op amps (monolithic)	4	8	▲
Voltage regulators	4	8	=
LIGHT-EMITTING DIODES	6	9	▲
MEMORY ICs			
Bipolar	6	9	▲
CCDs	6	10	▲
MOS	5	8	▲
MICROPROCESSORS			
Bipolar	5	9	▲
MOS	4	8	▲
PACKAGED CIRCUITS			
A/D converters	5	10	=
D/A converters	5	10	=
Instrumentation amps	5	9	▼
Sample/hold amps	6	10	▼

PRODUCT	LEADTIME IN WEEKS Min.	Max.	Trend
PANEL METERS	7	11	▲
PRINTED CIRCUITS			
Multilayer	5	9	▲
Two-sided	5	8	▲
READOUTS & DISPLAYS	4	8	▼
RELAYS			
Crystal can	5	9	▲
General purpose	5	9	▲
Reed	6	9	▲
Solid-state	5	10	▲
Stepping	5	9	▲
Telephone	6	11	▲
RESISTORS, FIXED			
Composition	5	8	▲
Dep. carbon & carbon-film	5	10	▲
Metal-film	4	10	▲
Networks	5	9	▲
Wirewound	4	10	▲
RESISTORS, VARIABLE			
Non-wirewound			
non-precision	5	10	▲
precision	5	9	▲
trimmers	4	10	▲
Wirewound			
non-precision	5	10	▲
precision	5	10	▲
trimmers	5	9	▲
SEMICONDUCTORS			
FETs	5	9	▲
Power rectifiers	4	9	▲
Power transistors	5	8	▲
SCRs & triacs	5	9	▲
Silicon switching transistors	4	9	▲
Switching diodes	5	8	▲
Zeners	4	7	▲
SWITCHES			
Dual in-line	5	10	▲
Lighted pushbutton	5	9	▼
Pushbutton	7	10	▲
Rotary	5	10	▲
Snap action	4	9	▲
WIRE & CABLE	5	10	▲

Leadtimes are based on recent figures supplied by a select group of Electronic Business magazine's readers. The figures are averages and represent the time necessary to allocate manufacturing capacity to build and ship a medium-sized order for a moderately popular item.

For more information, Circle No. 35

GREAT MOMENTS I

The Statue of Reliability.

An inspiration to components everywhere.

And a reminder to our customers of the great strides made by Corning throughout component history.

In Miss Reliability's raised hand, she holds three lightning bolts. These are symbolic of our fast delivery, rapid turnaround and quick anticipation of our customers' needs.

The eight star points on her crown signify the eight vital Corning advantages.

Superior component reliability. Reliable promise dates. Reliable engineering support. Reliable availability. Reliable service. Reliable QC testing. Reliable distributors. And our total dedication to work closely with our customers.

In her left hand, she holds the Corning

OMPONENT HISTORY

components catalog, the standard of the industry.

A book filled with historic innovations and full specs on all the Corning metal film resistors, glass and ceramic capacitors and miniature tantalum capacitors.

Her enigmatic smile is for all the products and improvements currently under wraps.

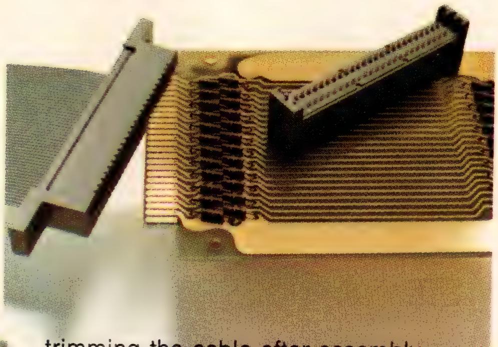
The Statue of Reliability. Built by the industry's leading supplier of quality components.

Corning Glass Works, Electronic Products Division, Corning, New York 14830, (607) 974-8692.

CORNING

For more information, Circle No. 36

Design with the complete flat cable/connector system.



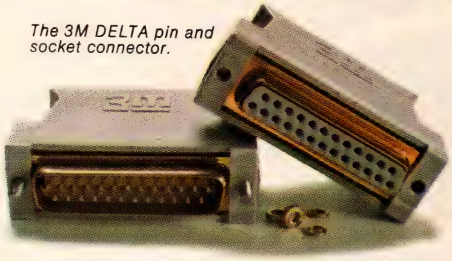
Assembly-cost savings are built in when you design a package with "Scotchflex" flat cable and connectors. But more important, 3M Company offers you the full reliability of a one-source system: cable *plus* connectors *plus* the inexpensive assembly aids that crimp the connections quickly and securely (with no special operator training required).

The fast, simple "Scotchflex" assembly sequence makes as many as 50 simultaneous multiple connections in seconds, without stripping, soldering or trimming the cable after assembly.

Connector units provide positive alignment with precisely spaced conductors in 3M's flat, flexible PVC cable. The connector contacts strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

With cable, connectors and assembly tools from one design and manufacturing source, you have added assurance the connection will be made surely, with no shorts or "opens."

And "Scotchflex" now offers you more design freedom than ever. From stock you can choose shielded and non-shielded 24-30 AWG cable with 10 to 50 conductors, and an ever-increasing variety of more than 100 connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards, or headers for de-pluggable applications. 3M's DELTA "D" type pin and socket connectors are now also available. For full information, write Dept. EAH-1, 3M Center, St. Paul, MN 55101.



The 3M DELTA pin and socket connector.

3M COMPANY

3M's "Scotchflex" line.

See our catalog in EEM—Page 1056.

"Scotchflex" is a registered trademark of 3M Co.

For more information, Circle No. 37

µP hooks up with satellite to keep ultra-accurate time

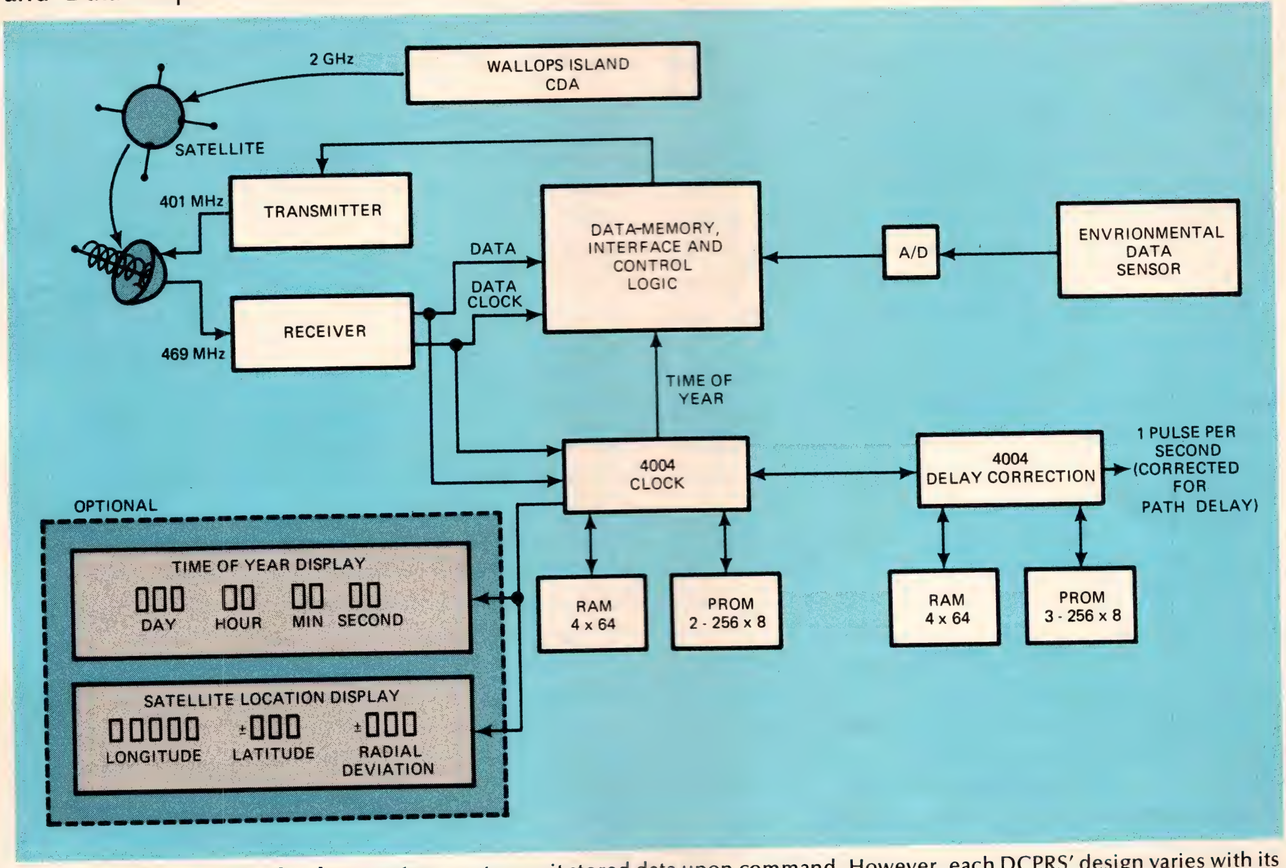
About five years ago, the National Oceanic and Atmospheric Administration (NOAA) asked a group of engineers at the National Bureau of Standards (NBS) to closely synchronize a number of isolated data-collection systems, many in remote locations. These engineers then developed an unusual but very accurate satellite-controlled µP clock which far surpassed the original specs: Each remote clock offers 40-µsec resolution between events, and all operate within 50 µsec of a NBS atomic-time reference in Boulder, CO!

Remote data collected with ease

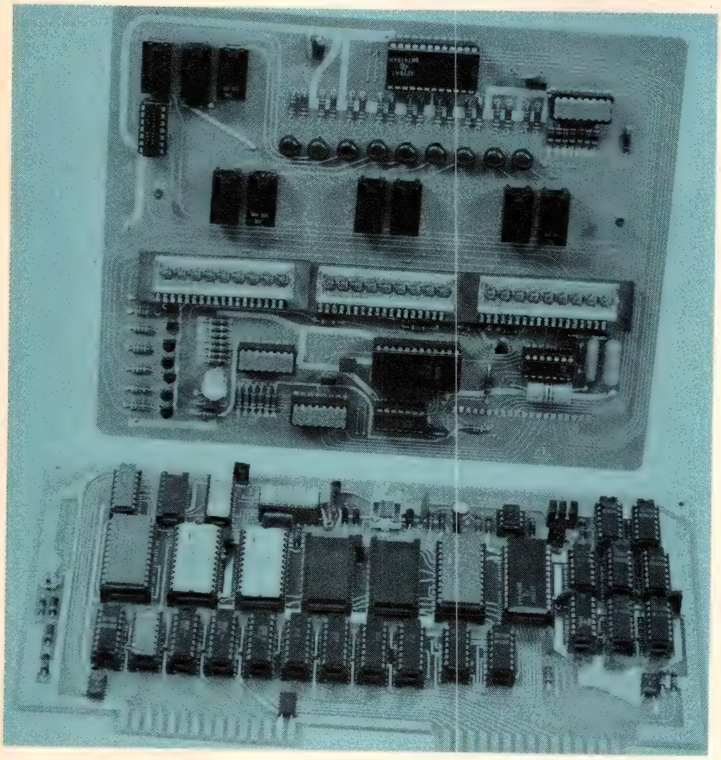
In this system a special interrogation signal, generated at the Wallops Island (VA) Command and Data Acquisition Station (CDA), travels via satellite to remote observing platforms such as buoys, automatic weather stations, ships, aircraft and balloons. After reconstructing the time code, these platforms date data as collected or schedule data transmissions back to the satellites.

This initial interrogation signal then combines time information with relay-satellite location data. Equipment at the CDA maintains and verifies Coordinated Universal Time (UTC) to within a few µsec of the master clock at Boulder, CO. Two independent atomic clocks at the CDA provide system redundancy, and both operate on rechargeable batteries for up to four hours of emergency power.

NOAA provides raw-orbit predictions for the two satellites; a Control Data CDC-6600 at Boulder then converts this data into a format



Illustrating full capability, the above system can transmit stored data upon command. However, each DCPRS' design varies with its needs: Different data-storage requirements dictate different RAM sizes, some stations do not need delay-time correction accuracy, and others transmit data on a pre-arranged schedule rather than on command.



While an entire platform, including transmitter and receiver, could include up to six boards of logic, these two boards contain the entire μP clock and its support circuitry **(bottom),** and the optional readout display with its multiplexing and strobe circuitry **(top).**

understood by the platform processors. From Boulder, the converted data goes to Wallops Island for multiplexing with the time-code.

The two satellites now receive separate but identical transmissions over S-band (about 2 GHz) for relay to the remote platforms on about 469 MHz. One part of this 50-bit word contains the multiplexed time/satellite-location information, and another portion addresses and activates selected platforms.

Each data-collection platform-radio set (DCP-RS), consisting of a receiver/transmitter set, first demodulates the interrogation message into data (the 50-bit word) and data-clock (a 100-Hz reference square wave) outputs.

Then an Intel 4004 μP, controlling DCPRS operations, gains symbol synchronization by looking at the data clock, and next samples and stores the data. The μP must also achieve data sync to determine the significance of any particular bit sequence and where to store this data. Interrogation messages repeat every half second, and a sequence must iterate 60 times to completely relay the time-code message. Since this 30-sec sequence also repeats itself, the μP continually verifies stored data by comparing RAM with newly received values, making corrections whenever errors are detected.

Smart clock corrects itself

Before the time-code value appears on the display, the μP corrects it for both propagation delay and variations in satellite position. The initial time signal advances 260,000 μsec before transmission by the CDA; this first-order correction brings the time code to within 10 msec of the NBS reference when it arrives at the platform.

The relay satellites follow "geostationary" orbits, but as truly geostationary orbits are impossible to achieve, the satellites insert cyclic propagation-delay variations themselves.

A second 4004 then takes the satellite-position data received from the CDA and calculates a correction delay for addition or subtraction to the time code. The signal now follows within 50 μsec of the NBS atomic clock.

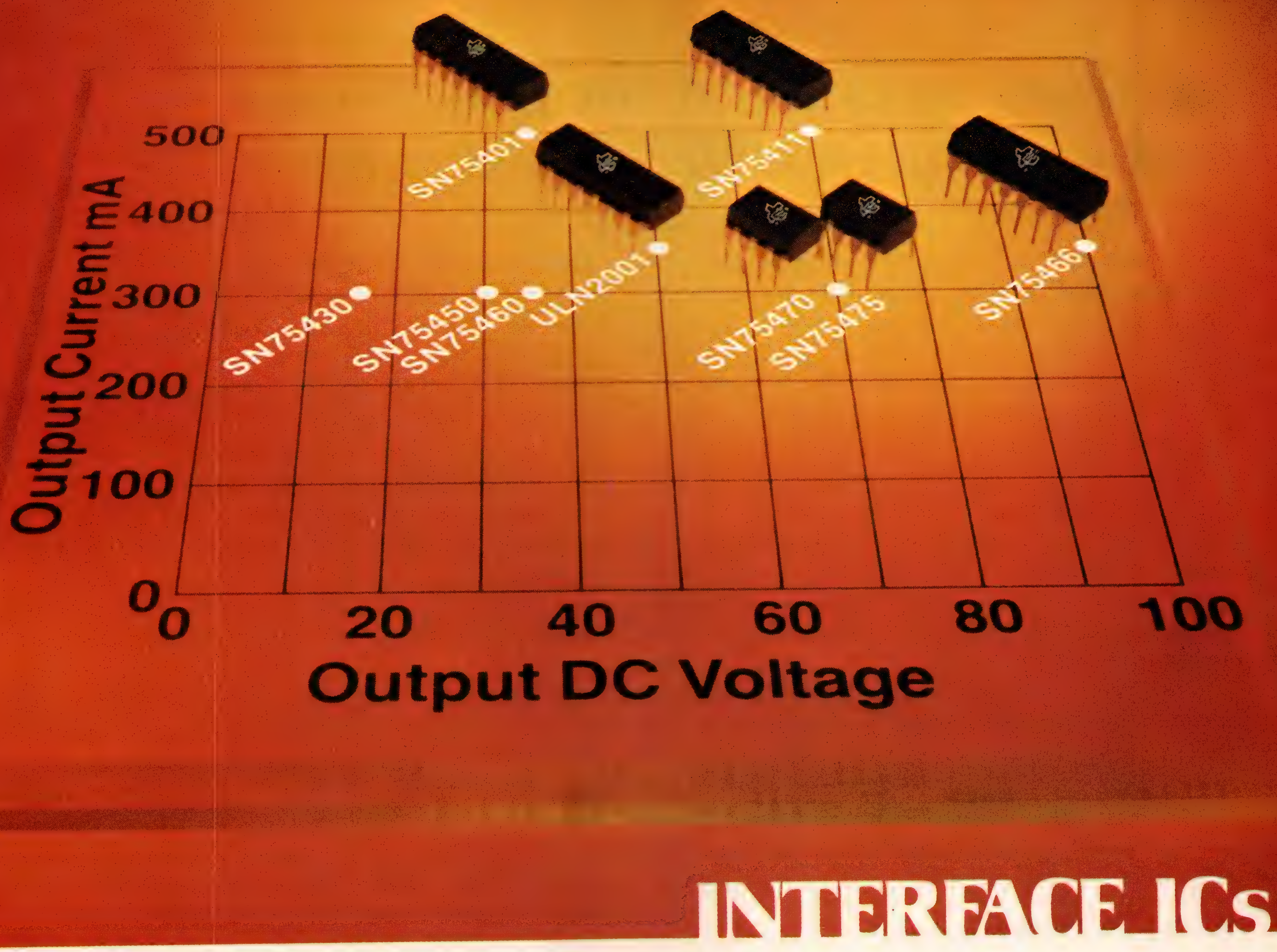
After establishing an initial time code, the μP's own system clock increments that code. Each complete cycle of the data clock represents 0.01 atomic second, and the μP compares its divided oscillator frequency to this incoming data clock. Upon loss of the data clock, the internal oscillator continues to provide the 0.01-sec count, maintaining RAM-clock and display accuracy.

Each platform usually responds to a daily satellite interrogation initiated when the platform detects its own address in the 50-bit word. It then transmits time-coded environmental data collected since the last interrogation to the CDA for storage and later evaluation.

Systems go unattended for months

Providing both total platform control and time sync, the two 4004's replace the 80 TTL IC's that NBS's Wayne Hanson calls "a random-logic wiring nightmare." As these units may not receive any attention over long periods of time and often run on batteries, they should consume as little power as possible: The μP system far outperforms power-hungry TTL in this area.

Hanson also mentioned that two years ago, when system development began, the 4004 proved the lowest cost off-the-shelf μP available. "We challenged ourselves with developing as inexpensive a system as possible, and using a microprocessor helped significantly. Although this system was developed for NOAA, the applied concepts would be most useful in developing a permanent NBS satellite-broadcast service. Our present high-frequency broadcast service, WWV, meets the very important criteria of simplicity, no user labor and low cost. Changing to satellites, we now see, would not violate these criteria: A microprocessor-based system such as ours would certainly make this service available to anyone for a very small investment while keeping data acquisition simple." ☐



Broadest choice. Highest output power. New TI peripheral drivers.

Thirty-seven devices including the industry leaders, TI's SN75450 and SN75460 Series. Twenty-one are brand new. The highest output power capability available. With a spread of 300-500 mA and 15-100 V, you'll now have fewer problems matching current/voltage combinations to design requirements.

Being single package, monolithic devices, these new linear ICs save assembly time. Improve reliability. Cut component costs. Rid p.c. boards of unnecessary clutter.

And no problem with driving inductive loads. TI's new SN75475 and SN75466/67/68/69 have output clamp diodes built-in on the chip. No externals required.

TI PERIPHERAL DRIVER FAMILY

	No. per Package	Latch-up Voltage	Typical Speed	Logic Type	Package
SN75430-SN75434	2	15V	13ns	All	N/J/P/JG
SN75450-SN75454	2	20V	20ns	All	N/J/P/JG
SN75460-SN75464	2	30V	42ns	All	N/J/P/JG
SN75470-SN75474	2	55V	42ns	All	N/J/P/JG
SN75401-SN75404	2	30V	42ns	All	NE
SN75411-SN75414	2	55V	42ns	All	NE
SN75475	2	55V	42ns	NAND	P/JG
ULN2001-ULN2004	7	50V	1μs	Inverter	N/J
SN75466-SN75469	7	60V	1μs	Inverter	N/J

N=14-pin plastic DIP; J=14-pin ceramic DIP; P=8-pin plastic DIP; JG=8-pin ceramic DIP; NE=Heat sink 14-pin plastic DIP.

Another new wrinkle: the SN75401 and SN75411 Series come in a special low thermal impedance (NE) package with copper-clad silver-plated leads. You have a choice of logic functions – AND, NAND, NOR, OR – as well as packages. Excellent availability; competitive prices.

New Data Book: For your personal copy of TI's hot-off-the-press Peripheral Driver Data Book, write Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
INCORPORATED

For more information, Circle No. 38

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63075

μP eliminates need for codebooks and crystals in UHF/VHF scanner

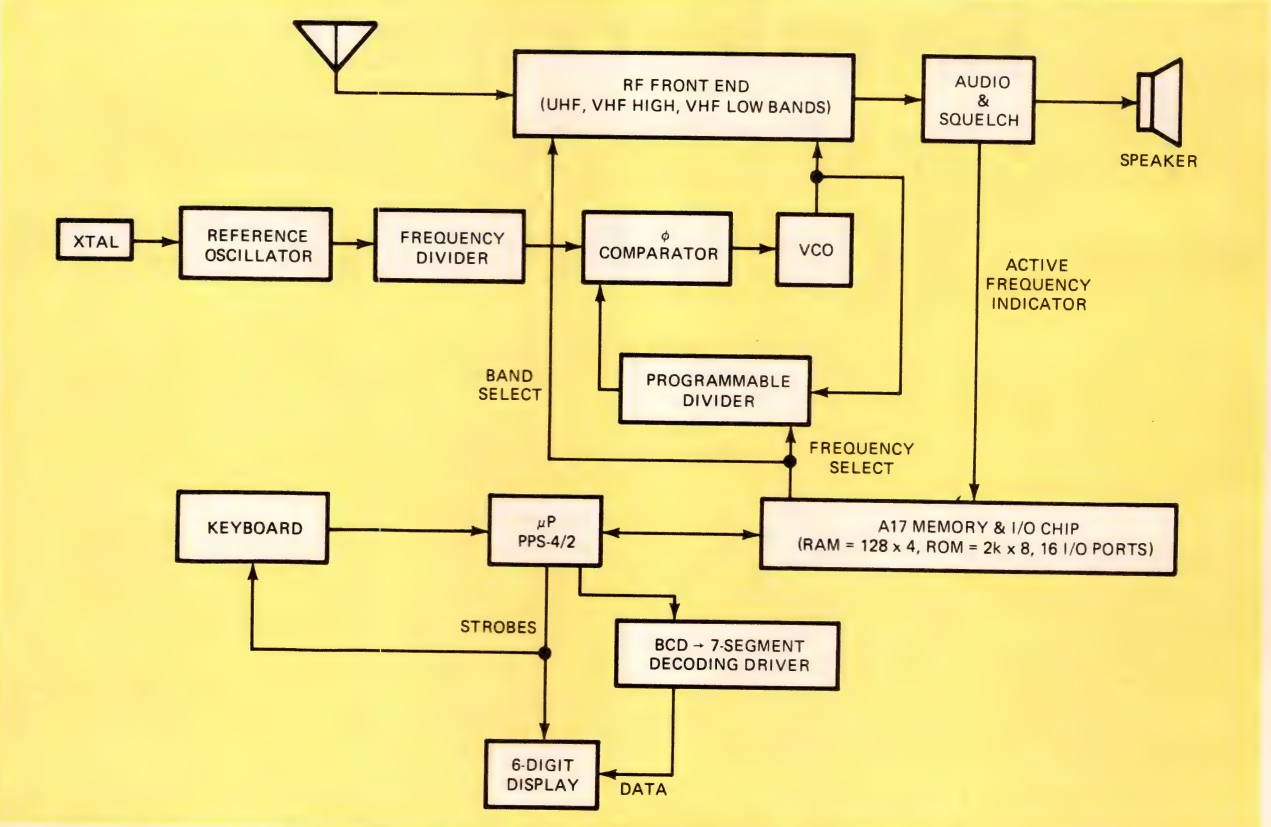
Public service channels (not to be confused with Citizens Band, or CB), provide communication links for police and fire departments, weather stations, mariners, rescue groups and businesses—all operating on FCC-assigned frequencies. The layman, however, merely monitors such transmissions and cannot reply as with CB.

Most people who participate in this activity use scanners (multifrequency receivers that continually jump from one channel to another, stopping only at active channels and continuing the scan when those transmissions end). Because each agency across the country operates on a FCC-assigned frequency, a listener must first look in a codebook or frequency directory to find the frequencies for his neighborhood agencies. He then assigns these frequencies to the channels in his scanner, generally by plugging in a crystal for each one. Thus, the purchase of a scanner alone usually will not allow a listener to get "on the air"; he must also obtain the necessary crystals.

Monitor over 12,000 frequencies

Combining both search and scan functions, Tennelec, Inc.'s MCP-1 μP-controlled scanner eliminates the need for both codebook and crystals. Briefly, the unit employs an internal phase-locked-loop frequency-synthesis technique to scan a particular segment, stopping to monitor any transmissions in progress. A 6-digit display then indicates the signal's frequency so the operator may note it and later return. He thus first chooses those frequencies he wishes to scan regularly and then enters them into memory for repeated use.

A Rockwell PPS-4/2 4-bit p-channel microprocessor controls the complete operation. In search mode, the operator enters the starting frequency, then hits the "ENTER SEARCH" key. After determining that this beginning point is within the receiver's range, the μP selects the proper RF band and figures the binary code needed by the programmable divider to detect the desired frequency. The MCP-1 next scans the band in 256 5-kHz steps at the rate of 10 steps/second, rippling the display as it searches; upon completion the μP repeats the search from the original starting frequency. Hitting the "END



This search/scan system takes advantage of Rockwell's A17 chip which interfaces directly to the PPS-4/2, thus greatly expanding I/O capabilities while also providing all necessary memory.

Mas/Ter INTERCONNECT SYSTEM INSULATION DISPLACEMENT CONNECTORS

High-speed mass termination that lowers your total installed cost! Here's the most exciting advancement in connector technology since Cannon introduced D Subminiatures—our new Mas/Ter-D Subminiature rectangular series of connectors and Mas/Ter-UND header series.

Designed to lower your total installed cost with a new level of reliability in mass terminating up to 50 conductors... quickly... error-free!

Look at these advantages: ☐ 25% more conductor surface contacted. ☐ Integral strain relief on the conductor insulator. ☐ Uniform contact force under extreme temperature, shock and vibration. ☐ Mas/Ter-UND accommodates 26 thru 28 AWG, while Mas/Ter-D offers two ranges of 22/24 and 26/28 AWG.

With the Mas/Ter Interconnect System, the entire connector is terminated at one time with no insulation stripping, no complex tooling... using standard round conductor flat cable or individual wires, solid or stranded. The contact penetrates and displaces the insulation without severing the conductor and still provides insulation support to the wire. Integral contact spring action wipes the conductor during termination to produce a high-force, low-resistance interface.

Mas/Ter-UND connectors and pin headers are intermateable and intermountable with other similar connectors, and Mas/Ter-D pin-and-socket connectors are fully intermateable and intermountable with Cannon's D Subminiature series.

These are only the first of a growing family of insulation displacement connectors coming your way from Cannon.

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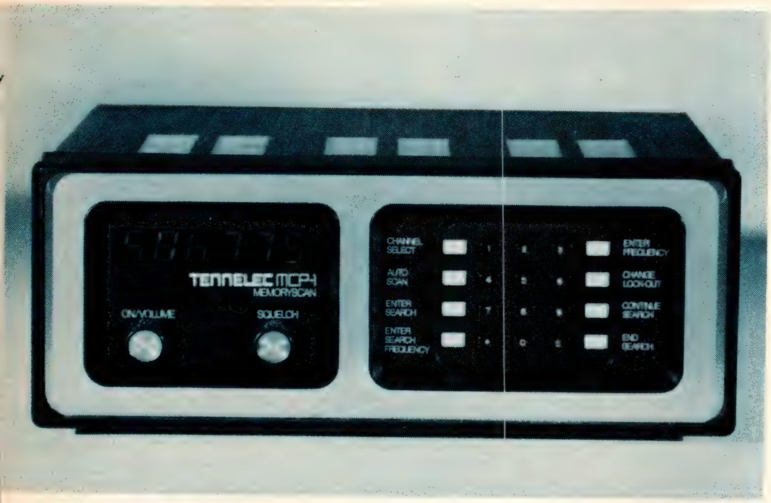

Capable of searching the entire UHF, VHF-low and VHF-high bands for activity, Tennelec's MCP-1 notes active frequencies and stores them in RAM for later recall—automatically or at the touch of a button.

SEARCH" and "ENTER SEARCH" keys consecutively moves the starting frequency, allowing the scanner to walk up the entire band.

When the receiver stops at a frequency of interest, pushing the "ENTER SEARCH FREQUENCY" button selectively assigns it to one of 16 memory channels in RAM so the μP can return to the frequency upon command.

While the search mode allows detection of any active frequencies, the scan mode provides repeated monitoring of any selected ones. The operator can thus assign frequencies to as many of the 16 memory channels as he desires; the μP then scans these frequencies, stopping to listen to any transmissions. While stopped, the display shows the assigned memory channel and frequency of the transmission being monitored.

This μP requires almost no peripherals

The original MCP-1 system was developed using four Rockwell chips centered around their PPS-4, according to Tennelec's Vice-President of Product Development, Bill Baker. "About two years ago when we first decided to use microprocessors, we knocked on lots of doors, saw plenty of glossy PR material, but found few manufacturers who delivered reliably. For our application we needed powerful I/O and substantial manufacturer support. We had gained some experience with other processors and were aware of several problems to avoid, but Rockwell didn't worry us. They were already delivering large quantities to several customers, so we could obviously count on regular delivery. Also, their system seemed ideal: Special chips greatly reduced interface problems, the TTL-compatible hardware just 'bolted on', and their software best suited our demands—the system was painless to use.

"When Rockwell later introduced their PPS-4/2, we redesigned our system around it, eliminating two chips in the process and making our product even more price competitive. We did, however, lose a little I/O capability, and so the 7-segment display decoding originally done in software was transferred to a dedicated chip.

"Now, after two years," Baker added, "we're still quite comfortable with Rockwell's product and service. Our patented design allows great flexibility, particularly regarding new features. For a total of $1200 we can completely revamp our software to change the functional abilities of our receiver; our competitors would require much more time and expense to do the same using discrete-logic designs. This naturally places us in a most favorable marketing position."

Baker did note, however, that μP's do not necessarily represent the only solution: "We are continually reviewing chip capabilities from other sources for our applications; but for now, the μP approach remains very attractive."□

Has a μP helped YOU lately?

EDN's μP Application Ideas section appears as a regular feature of every issue, presenting a designer's view of microprocessors in action. We select unique and interesting applications that illustrate the many different ways that μP's are being used in new products or systems. Emphasis is on the functions handled by the μP, features of the product or system made possible by the μP and advantages of the μP approach over others.

Have you designed and developed an interesting μP-based product? If you have, then please tell us about it. Your description should state the problem, indicate previous or alternate solutions (if any), explain basically what the μP is doing, discuss the μP's advantages and describe any design difficulties encountered. Concentrate your remarks on the μP. To complete your story, please include a block diagram and at least one black and white photograph of the product.

Send your entries:
μP Application Ideas
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A SIGNIFICANT ANNOUNCEMENT IF YOU'VE BEEN WAITING FOR A BREAKTHROUGH IN SMALL, PORTABLE DVM PERFORMANCE.

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The wait is over.

The Fluke 8040A, 4½-digit DVM has arrived. It's a handheld autoranging DVM, with the sophisticated performance of a benchtop instrument.

It has five measurement functions with a total of 26 ranges. True rms conversion techniques for all ac measurements. Autoranging and autozero. Extensive input overload protection. We made it truly portable, at a mere 2.5 pounds. And it's rugged enough to withstand the rigors of any field environment. We even designed a retractable hood, to make it easier to read in bright sunshine. It's been tested with transient overloads of 6 kV across the input with no damage.

DC voltage measurement from 10 MV to 1100V with basic accuracy of ±0.5%. AC and dc current from 10 nA to 1.999A with basic dc accuracy of ±0.3% and basic ac accuracy of ±1%. Resistance measurement from 10 mΩ to 19.999 MΩ with basic accuracy of ±0.2%.

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Sensitivity:	1 mV/°C or 1 mV/°F
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0°C to 15°C, 35°C to 50°C ambient:	Add 1°C(1.8°F) to above

You can also get temperature measuring capabilities with the 8040A.

There are two battery options: a rechargeable NiCad for 8 hours of line-free operation, or disposable alkaline batteries. 100V, 115V or 230V ac line-powered battery eliminator/chargers are available. Accessories include measurement probes for rf voltages, high current ac, high voltage dc, temperature, and deluxe test leads. A carrying case is also available.

At last. A truly portable 4½-digit autoranging DVM that's got everything you need. And for only $399*.

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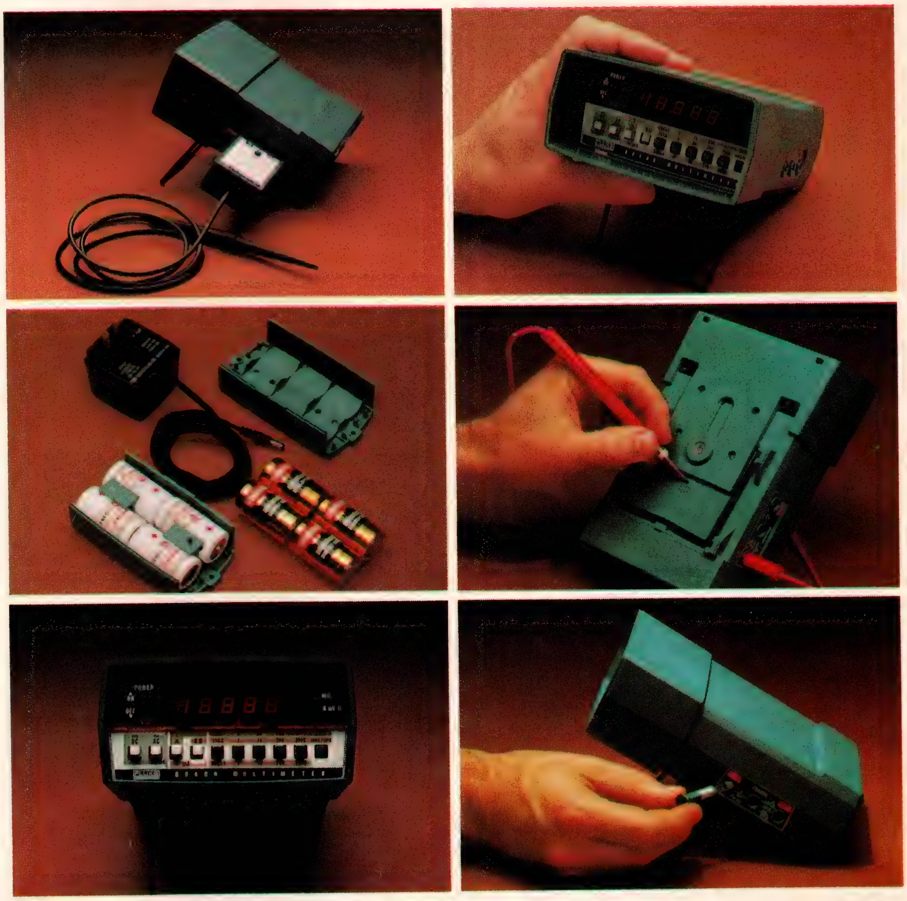
There aren't many small, inexpensive and portable DVM's around that can perform like the 8040A.



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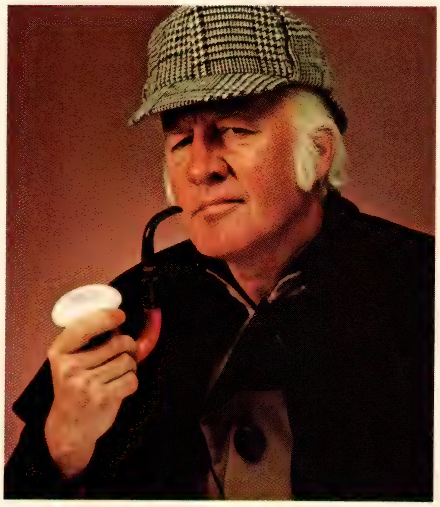
AN INVITATION TO LEARN WHY THE FLUKE 8500A IS CALLED THE WORLD'S FINEST DVM.



"It's not difficult to understand why it's called the finest. After all, it is a Fluke DVM, isn't it?"

We'd like to introduce you to a new concept in digital voltmeters.

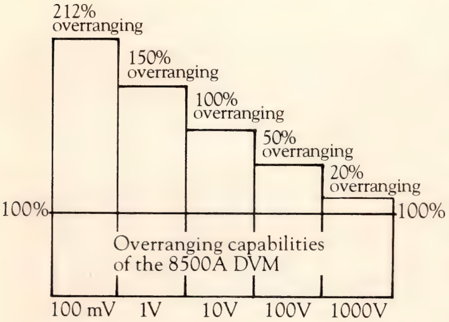
The Fluke 8500A.

It's a measurement system—not a dedicated instrument, but a bus-oriented, microprocessor-controlled measurement device. Modules which convert parameters, such as ac voltage, resistance or current, are simply plugged into any available slot in the bus structure. The microprocessor then talks to the module and displays the new value in the desired parameter.

That's the heart of the 8500A—unlimited measurement architecture. At any time, different measurement, control or servicing modules can be plugged in the bus.

And the 8500A is a different measuring device.

All for a basic system price of $2,695.*



Most other DVM's offer only 20%-60% overranging.

The 8500A is a high-speed 5½-digit DVM capable of 500 readings per second at full resolution and accuracy. Fluke's patented Recirculating Remainder (R^2) A/D Conversion technique is used for high, long-term accuracy and linearity. There's a calibration memory that allows for automatic correction of calibration error. And it's the only systems DVM that measures ac and dc current.

DC voltage measurement and dc ratio are standard features. DC voltages are measured over five ranges, with resolution between 1 μV and 10 mV and a basic accuracy of ±0.001% (10 ppm) for 24 hours, 20°C ±1°C. Starting with the lowest range, a maximum display of 312.5 mV is possible with a resolution of 1 μV. Displays on the lower ranges are in volts, followed by an exponent display of −3.

Two types of ac measurement options are available for the 8500A. While only one can be installed in the instrument at a time, removing one option and installing the other requires a minimum of time and/or operator training. At power up or after reset, the front panel displays whether the averaging converter, true rms converter or neither is installed in the instrument.

The Averaging Converter (Option -01) measures up to 1000V ac on four ranges with a bandwidth from 30 Hz to 100 kHz and accuracies up to ±0.05% + 5 digits. The True RMS Converter (Option -09) measures up to 1000V ac on four ranges with a bandwidth from 10 Hz to 300 kHz and accuracies up to ±0.1% + 15 digits.

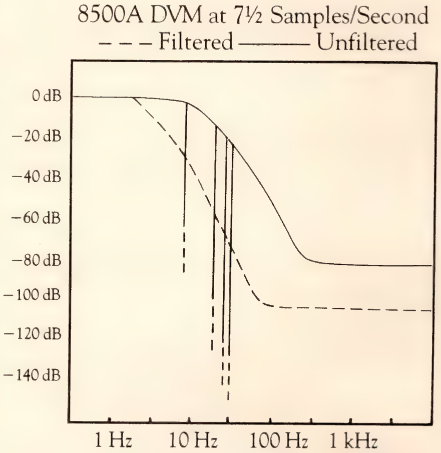
Resistance measurements can be made on eight ranges from 10Ω full scale to 100 MΩ full scale with the Ohms Converter (Option -02). Basic accuracy from 100Ω to 1 MΩ is ±0.003% + 1 digit, with resolutions up to 100 μΩ obtainable.

Both ac and dc current can be measured with the Current Module (Option -03) provided one of the ac options is installed in addition to the basic dc. Current measurements to 1A can be made with sensitivity to 1 nA. Accuracies to ±0.03% + 10 digits, for dc readings and to ±0.06% + 8 digits for ac readings. Bandwidth of the 100 μA through Amp ranges is 30 Hz to 10 kHz. For the 1A range only, the bandwidth is 30 Hz to 3 kHz.

Guaranteed accuracies for the 8500A measurement options are based on 90 days, 18°C to 23°C.

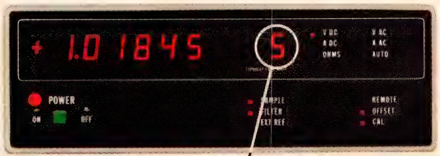
Three Remote Interface options are available with the system. Only one of the three may be installed at a time; however, one can be easily exchanged for another when the top cover is removed. This allows the instrument to be used with more than one interface system, requiring only that additional modules for the desired interfaces be obtained.

The IEEE Standard 488-1975 Bus Module (Option -05) provides an eight-bit (one byte) parallel interface. The Bit Serial Asychronous Interface Module (Option -06) interfaces the 8500A to systems using either RS232B, RS232C, or Current Loop interface. Selection of type and Baud rate is made with bit switches accessible through an entry



Fantastic noise rejection without sacrificing speed.

Automatic correction for zero, offset, calibration and drift with microprocessor controlled memory storage.



Extra digit of resolution.

As an extra bonus, the range digit can be converted to a 6th measurement digit—for 6½ digits of resolution.

port on the rear panel. And the Parallel Interface Module (Option -07) provides a 16-bit duplex register interface compatible with mini-computer and microprocessor systems.

A non-volatile calibration memory module stores correction factors desired from a standard input during CAL mode operations. It can also be used to compensate for long-term drift, eliminating the need for manual adjustments or trips to the calibration laboratory. This allows the operator to remove power from the instrument or the system to suffer a power failure without loss of automatic calibration factors. The battery permanently installed on the module will keep power on the memory to retain the stored data in excess of 90 days after removal of power.

Service capability is one of the strong points in the 8500A program. Of course, extensive overload protection has been designed into the instrument. But should problems develop, most of them can be handled in the field by using the available service aids. An extender card, a bus monitor, a test module, and a static controller, together with diagnostic programs and the microprocessor control should handle 60%-80% of most troubleshooting problems.

If you've read this far, you know why the 8500A is called the world's finest DVM. Microprocessor control, modular design, complete measurement and systems interface capability and ease of service are all combined in one instrument. And the best thing about it is that it's made by Fluke. So you know you can count on quality and service throughout the world.

The 8500A. One more reason why Fluke is the leader in digital voltmeters.

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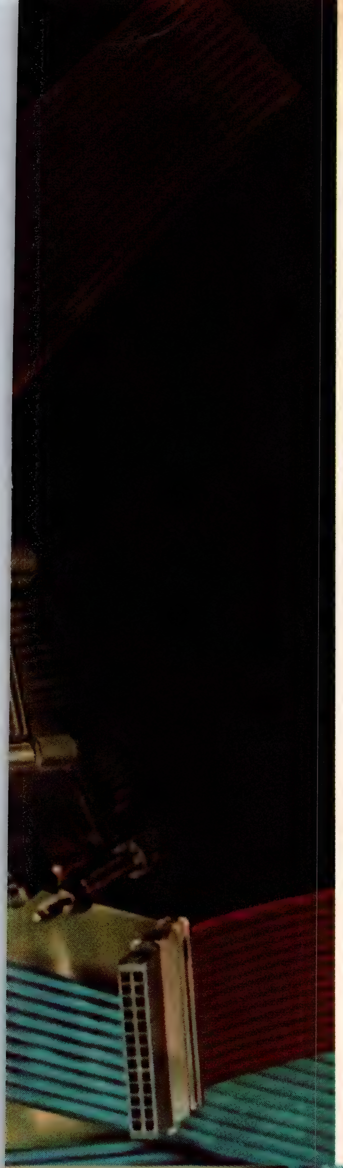
Now the line of AMP Coaxial Ribbon Cable Assemblies is wider than ever.

And so is your design range.



The introduction of AMP Coaxial Ribbon Cable assemblies represented a major breakthrough in interconnection technology. Lower costs with no compromise in performance. Now, AMP has broadened the line to give you an extremely wide range of high speed, low noise interconnections.

AMP ribbon coax is available in 50-, 75- and 93-ohm ratings, 6 to 26 positions, on .100-inch centers. Or in a 95-ohm rating on .125-inch centers.

Multi-position connectors mate with .025²-inch posts, either 90° board-mount pin headers or I/O posts. Included are the new paddle-card and flanged types.

We can supply complete ribbon coaxial cable/connector assemblies of any length to fit your requirements. Or provide all the cable, connectors, and tooling you need to make your own.

Either way you get professional back-up by AMP field and home office engineers. They work with you from the prototype stage through production—and on to future design.

For more information on the design opportunities you get with AMP's extended range of Coaxial Ribbon Cable assemblies, call Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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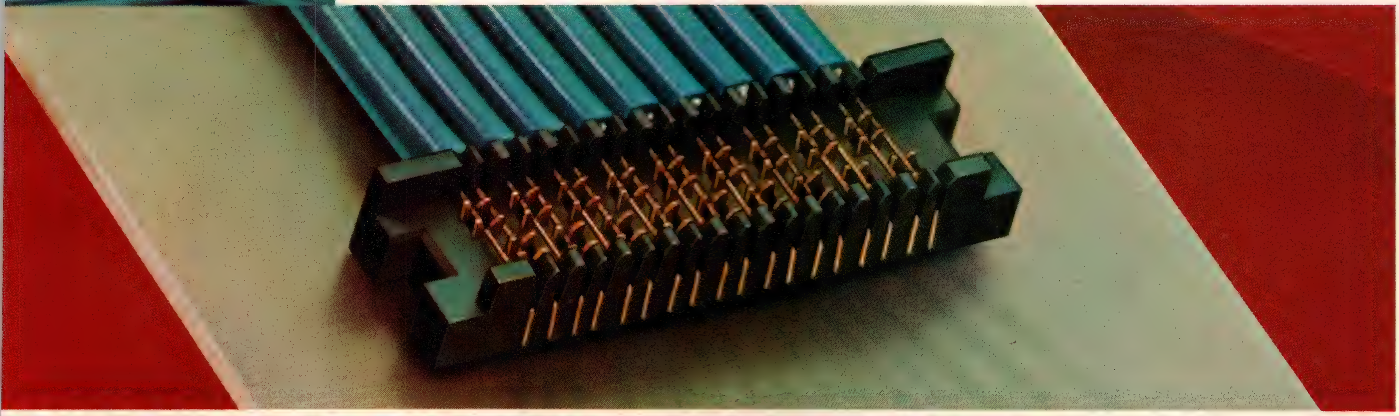

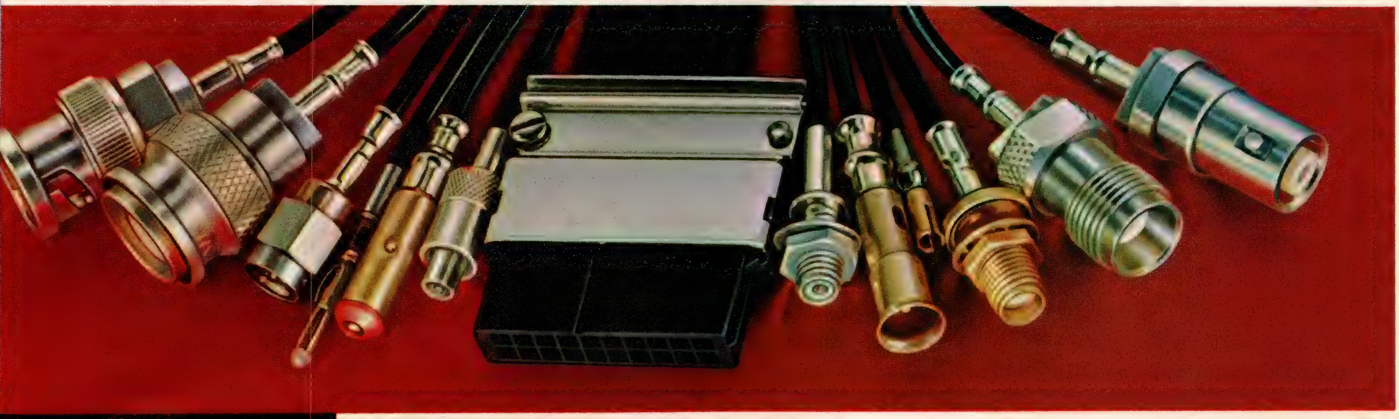

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SPECIAL REPORT

Connector systems— A revealing look at some of today's "on-the-move" technologies

Connectors no longer fit into the "nuts-and-bolts" mold. Today, they can be as crucial to success as any exotic active component.

Tom Ormond, Associate Editor

Though connectors come in all shapes and sizes, this report concentrates on four major styles currently showing extensive design activity: ZIF, flat cable, fiber optic and circular.

Since these connector areas represent quite a "something-old, something-new" ensemble, tieing them together in a "high level of product-design activity" theme would prove rather tenuous. Therefore, we break our coverage into four mini-reports to avoid reader confusion.

ZIF's: Have they "connected" yet?

Not even the most zealous manufacturer would classify the ZIF (zero-insertion-force) connector as a "space-age" product. Available for a number of years, its advantages couldn't offset the high cost and mechanical complexity of the early connector designs.

But today, the scale has begun to tip the other way. Applications requiring many connector-mating cycles (test equipment) are a natural for ZIF, as are those where insertion and withdrawal forces must be minimized due to the high number of contacts/connector. Pressure in this last area is already evidenced in the rack and panel-connector market, and contact-density demands will probably continue to increase.

PC-board connectors, one of the first market areas invaded by the ZIF concept, proves another area of ZIF resurgence. Obviously, any side-entry card-edge connector must be a ZIF design. Introduction of μP's and related LSI circuits (alone creating a need for ZIF IC sockets) has brought a higher level of computing power onto pc boards and dramatically increased the need for I/O connections on three board edges. The ZIF concept thus shows all the qualifications of a design idea with a ripe market.

What is this thing called ZIF?

A ZIF connector is best described as "any connector which permits insertion and withdrawal of its mating units, without achieving intimate contact during the interface cycle." Most practical designs have some interposer actuation where the activating member (cam, rod, etc.) applies force to a plastic interposer that in turn moves the contacts. This design principle is a rather radical

Something old, something new could be the theme of our connector-systems report. The new connector type is of course the fiber optic, but some older styles—ZIF, flat cable and circular—get their time in the spotlight, too. *(AMP Incorporated)*

departure from "classical" connector philosophy.

Historically, connector designs used contact resistance as an important asset for high-reliability performance, and therefore provided increased insertion forces and/or significant contact-wiping action to insure low contact resistance. Since the ZIF design seemingly violates these "classical" criteria, connector purists reasoned that its performance couldn't possibly measure up to standard designs. Nothing proved further from the truth.

A positive look at the negatives

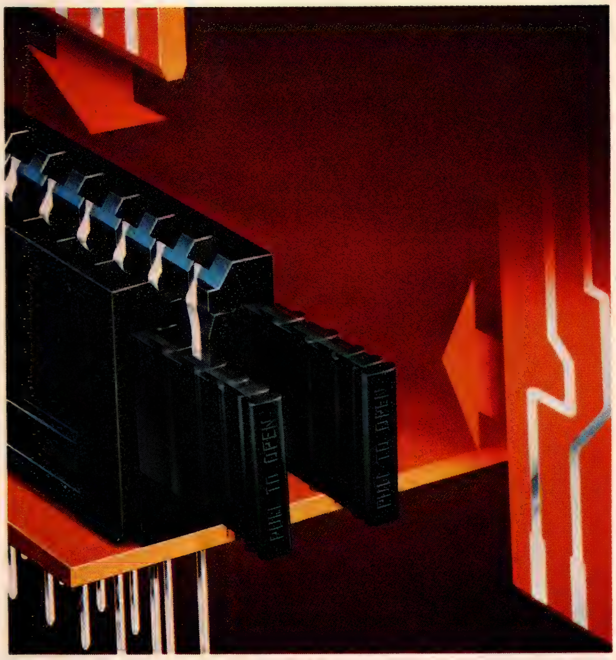
Many of the big connector manufacturers (full-line houses—not just ZIF's) totally agree that most force specs used today have no meaning: The only truly qualitative spec is unit force or force/unit area.

ZIF connectors measure up well to this spec. Though not applied during the mating cycle, these connectors evidence a high level of unit force thanks to the mechanical advantage of the camming action. Equally important, since the ZIF provides minimal contact scoring as well, its design greatly extends connector lifetime.

Contact wiping is a plus feature in connector designs—especially when the interface handles low-current levels. Such action usually breaks down oxide build-ups that would otherwise impair performance in such applications.

Other than butt types, all contacts that strike a flat surface and exert force do tend to slide. As noted earlier, ZIF connectors evidence a high level of unit force; investigations indicate that these connectors also provide a wiping action. In fact, wiping action is inevitable in ZIF connectors if the contacts are properly designed and the exerted force extends throughout the contact-tolerance range.

Circulars can be a creditable solution for your high-density, pc-board I/O applications, thanks to the Nuline 901 Series from TRW/Cinch. Up to 85 size-22 contacts accommodated in a number-18 shell insert indicate the line's capability.



Board entry from either the side or top is a unique feature of this line of card-edge ZIF connectors from AMP Incorporated. Such capability proves quite useful in high-density packaging applications since it lends itself to use with I/O connections on three edges of a pc card.

What's on sale at the connector store?

AMP has two product lines—card-edge and rack and panel connectors. Requiring a minimum of 0.5-in. mounting width, the edge-board line will accommodate insertion from either the top or the side for high-density packaging applications. Designed for double-sided or multilayer boards from 0.054 to 0.071 in. thick, the connectors come with up to 280 contacts (140 dual positions).

Lever-operated cam and push-pull slides are among the several actuating mechanisms available. To establish electrical contact, the activating mechanism requires less than 0.5 in. of linear travel. When opened, contacts are withdrawn behind internal-housing barriers for protection during board insertion.

The CR series of rack and panel connectors incorporates a mechanical-advantage device for easily mating 40, 120 or 156 contacts. Mated-contact forces of 150 grams are typical, with several thousand mating cycles possible without performance degradation.

Both plug and receptacle halves are modular and permit variations in termination and conductor styles. Receptacle modules are supplied preloaded with posted contacts that accept either wrap-type termination or round-conductor flat-cable connectors. Plugs come unloaded for crimp snap-in contacts or loaded with insulation-displacement types for mass termination.

Burndy offers the QIKLATCH line of pc-board (single-sided type) connectors with solder-tail

Start with ZIF, add a little, and you wind up with the LIF (low-insertion-force) line of connectors offered by Bendix. These include 2-piece mother-daughter board combinations and I/O designs in 2-, 3- and 4-row patterns. The Brush Contact system used provides a 70 to 90% reduction in mating/unmating forces.

terminations. Designed for vertical board-to-backplane interconnections, this somewhat unique design uses no cams, levers or slides to effect contact mating. Rather, it employs a locking latch and take-up spring system that also provides mechanical stability.

Probably the most unique feature of this line is its GTH (gas-tight high-pressure) contacts. These designs are galling-types; with the high forces inherent in ZIF designs, oxide formations at the contact point reduce to a level that eliminates the need for gold-plating.

The list of manufacturers grows

What we've catalogued above are some of the standard lines of ZIF-connector offerings. But other companies—Bendix, Berg, GTE Sylvania and Molex, to mention a few—have already entered (or will enter soon) the ZIF-connector market. Bendix, in fact, is expanding a line of LIF (low-insertion-force) connectors that utilize a brush-contact system. And of course, other firms feature lines of ZIF IC sockets. Most of these designs are either for dedicated applications or custom designs.

The ZIF concept, then, still waits in the wings, ready for its call to center stage. This call, though, may not be long in coming. Repackaging of existing equipment design would require very extensive and costly changes to realize the full advantages of ZIF technology. However, with density requirements in continuous growth (especially in the computer/data-processing area), the next-generation of equipment designs might well be called "the ZIF age."

Flat-cable systems can't miss (?)

When EDN published a Special Report on flat-cable interconnection systems 13 months ago (Sept. 20, 1975), the technology had apparently reached a "can't-miss" plateau. While not relegated to a "back-shelf" status, flat-cable interconnects still have not overwhelmed the market.

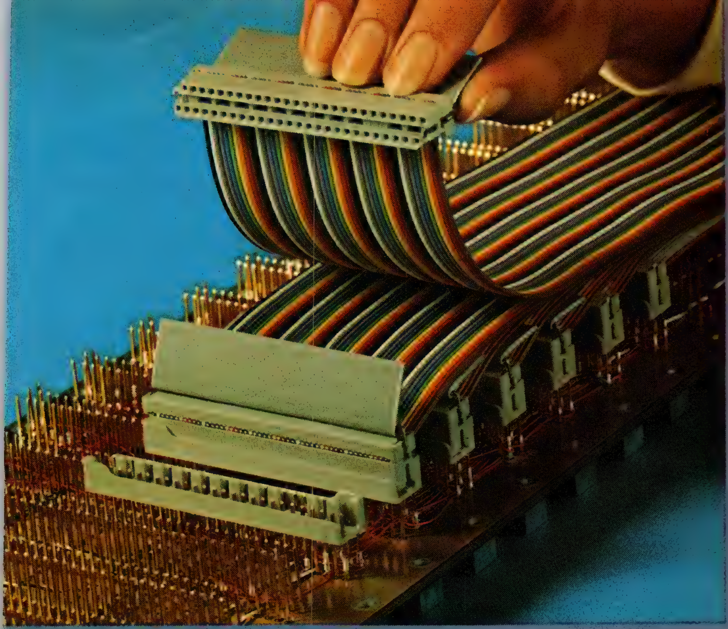
Based on our experience, we were somewhat mystified at this state of affairs and therefore asked the manufacturers for an explanation. L.W. Oliver, V.P. and Director of Business Development at ITT Cannon, offered his viewpoint. "To date, the major problem has been consumer awareness and a reluctance on the designers' part to make the rather drastic change from individually wired to flat-cable systems. However, this reluctance is apparently lessening, and more flat-cable systems are created or changed over as rapidly as the designers can work on them."

Mr. Oliver's comments seem well-founded since connectors for flat cable are more available now than at any time in the past. Many connector companies now create new designs to serve this mushrooming technology. Although obvious, this last statement is a made-to-order "segue" into a new product review.

Mass terminate with a single crimp

With their Mas/Ter interconnect system, ITT Cannon confronts those critics who say that all IDC (insulation-displacement-contact) connectors are look-alikes: The Mas/Ter brings mass termination concepts into both the Type-D and

Economy is a key feature of Burndy's METALOK BANTAM line of miniature circular connectors. Constructed of a high-strength plastic body, units come in eight shell sizes and use the TRIM TRIO contact system.



The backplane/mass-termination marriage has finally been consummated thanks to 3M's model 3307. Part of their Schotchflex system, this 50-position I/O connector simplifies backplane-equipment design by allowing connections directly over wire-wrap pins.

Product-line expansion is the name of the game at T&B/Ansley Corp. The latest addition to their line of mass-termination products is the "D" connector (shown in the left foreground) which incorporates a spread pitch-contact design that compensates for the difference in flat-cable conductor spacing (0.05 in.) and I/O mating contacts (0.0545 in.).

Type-UND market. Key to the system is a special spring-action contact.

This contact, essentially a cylinder, has its two halves pointed at the top, with a thin slit down the front and a wider slot part-way down the back. As a wire is terminated, the contact points penetrate the insulation and push it aside. Mating occurs in the thin front slit with the rear opening serving primarily as a strain relief. The line includes box-contact type receptacles and headers, and units can be used in either a cable termination or mid-cable, daisy-chain configuration.

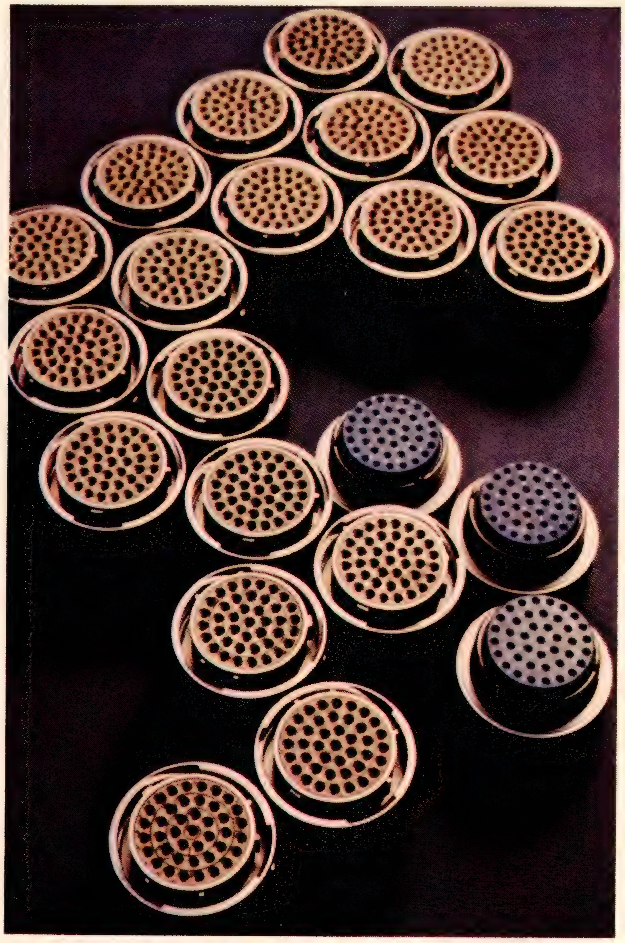
T&B/Ansley Corp. also offers a series of mass-termination type-"D" connectors. This line incorporates all the features and benefits offered by their BLUE MACS system—a one-piece connector design that speeds installation, offers self-aligning cable grooves that automatically position the cable conductors over the IDC's, and patented TULIP contacts that provide four mating interfaces per conductor. The series comes in 9, 15, 25 and 37 pin versions with male or female contacts.

Alpha Wire Corp., one of the oldest full-line wire and cable manufacturers, is also a new source of flat cables and flat-cable connectors. They offer a design that permits users to inspect the connections before covering and crimping. The connectors have staggered microetched tines to effect good conductor grip, as well as self-cleaning, dual-cantilever construction for lower resistance connections.

Berg Electronics, on the other hand, is an old-timer in the flat-cable connector field and has found it advisable to expand their line. The latest introductions include vertical headers, solder-to-pc-board connectors and a male DIP connector for terminating flexible flat cable. All these additions are totally compatible with their Quickie line of mass-termination flat-cable connectors.

Mating underwater in power-on condition is no problem for this environmentally sealed unit from Viking Industries. The secret of such success is a flexible bellows which accommodates changes in pressure and volume—problems that plague other designs.

The "mass-termination" concept has even invaded the world of backplane interconnections. By allowing connections directly over wire-wrap pins, the 3M 3307 Schotchflex 50-position connector offers true I/O capability. This system includes: the 50-position socket connector, a clip for strain relief between cable and connector, a keying header, a polarizing key and a locater plate used with Schotchflex assembly presses for proper cable/connector alignment during termination. The 3307 accommodates either 26 or 28



The increasing trend to plastics is evidenced in Amphenol's family of miniature environmental Merlin™ connectors which feature an all-plastic, contact-retention system. A hard-dielectric closed-entry socket insert and a hard-dielectric pin insert with a resilient face seal greatly increase end-use reliability.

AWG solid or stranded conductors as well as 30 AWG solid conductors.

The disadvantages of "unique" connectors

Mass termination, as embodied by the IDC concept, has proved the most significant breakthrough in the flat-cable connector market. Unfortunately, this breakthrough perpetuated a basic limitation—each manufacturer's connector required a unique and proprietary fixture to effect the termination. Now, thanks to Vector Electronic Co., the situation has changed.

Their P187 terminating system accommodates female IDC's from companies like AMP, T&B/Ansley, Berg, CW Industries, 3M, and Stanford Applied Engineering, as well as their own product. The fixture consists of two aluminum blocks with precision-milled slots to accurately position connector and ribbon cable. Spacing washers and stepped surfaces in both the pressure bar and base accommodate the different vertical dimensions of the various connectors. The fixture's surface configuration precludes any adjustments. Positive bottoming eliminates "operator feel" and the resultant variations in connector installation—the operator merely applies pressure until it stops.

A look in the crystal ball shows promise

Always tempting to predict a rosy future for a technology, an optimistic outlook for flat-cable interconnect systems seems totally justified. Of course, flat cable can't hope to find its way into every wiring application: Multi-breakout harnesses aren't made to order for flat-cable systems. But introductions like Vector's could open the floodgates. Designers like the security of second-source insurance; more companies should follow Vector's lead and develop tooling that accommodates multiple-connector types. The cable is there—as are the connectors in increasing numbers and varieties. Designers who consider the flat-cable system early enough to realize all its advantages can only wind up as winners.

"Hook-up" with fiber optics

With fiber optics, as with any other connector regimen, the primary design goal remains faithful low-loss transmission through the interconnection medium. The problem with fiber optics, then, is more one of new or different parameters rather than a new set of rules.

Fiber-optic connectors instigate no gold-vs.-tin controversy, no contact-resistance debates and no insertion-force problems. Rather, users must choose between single-fiber and bundle-cable connectors; metal and plastic connectors; and face new problems with cable alignment.

Basically, two disciplines exist for fiber-optic connectors: end-of-the-line cable termination (to a bulkhead connector on a piece of equipment or to a light source or photodetector), and cable-to-cable interconnections. These broad categories then raise the question of permanent splices or demountable connections that must be mated/unmated repeatedly.

The most common type of fiber-optic product in current use is the fiber-optic bundle. Termination technology for bundle cables has advanced fairly well, and cable-to-cable connections are not a major problem. However, "To get a little, you've got to give a little." In this case, what you give (trade-off) is signal attenuation to get reduced alignment problems.

A fiber-optic bundle, as the name implies, contains a number of fibers grouped together to form a single optical-signal path. Typically, these bundles show signal losses that can range anywhere from 50 to 1000 dB/km. Low-loss cables are available today that could minimize this attenuation figure, but the economics involved make the cost of such an "optic bundle" prohibitive.

However, many fiber bundles (both glass and plastic) currently exist with loss figures in the above cited range, that are more than adequate for a good number of short-range, data-transmission applications. A kilometer, approximately 3300 ft, is a considerable distance to run a cable from the computer to most peripherals. Cut the cable length by a factor of 100 to 200, and you drastically change the loss picture.

Single-fiber connectors still wanting

However, with long-range communications (where the data links do indeed run into miles), the above loss levels prove too high. Single-fiber cables work here, where today's technology has brought loss levels down to the 10-dB/km range. Unfortunately, a high-quality connector for a single-fiber cable is the major area requiring additional development.

While figures like 0.1 dB are being quoted in the laboratory, the best commercially available connectors still evidence a 1-dB loss level. Though acceptable, this figure is obtained only when the optic fibers are precisely aligned in a single-fiber splice.

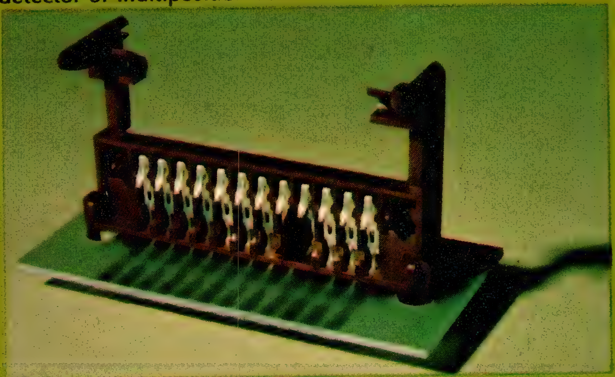
Lateral or axial alignment is the most critical parameter regarding splices. An axial displacement equal to half the fiber-core diameter can cause connection losses in the 4-5-dB range. Separable connectors add another dimension to the problem.

In such connectors, cable end-surface integrity dictates the presence of a gap between the mating faces. However, this gap can't get too large: Spacing equal to 50% of the fiber-core diameter can lead to loss levels even greater than those resulting from lateral misalignment. When you consider that we're talking in terms of micrometers (and such figures must be reflected into the machining tolerances of the connectors), you can appreciate the problem.

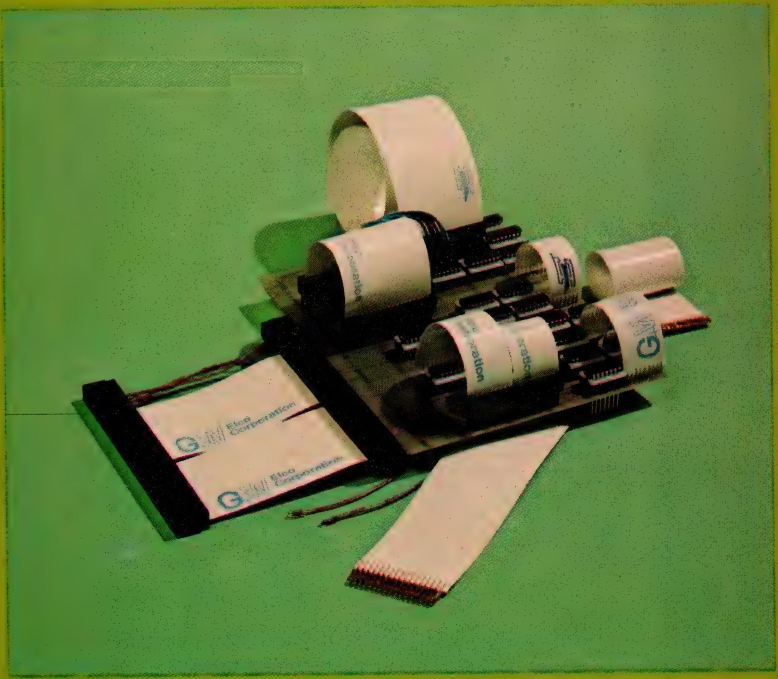
But why go to all the bother of producing mating connectors for fiber-optic cables. Well, some real industry giants number themselves in the fiber-optic connector business—companies like ITT Cannon, Bunker Ramo/Amphenol, AMP, Berg and Burndy—and one of them (AMP) states a very good case for the "why-bother" question.

"Fiber-optic cables are a promising next-generation data-transmission medium. They offer many significant advantages over present-day coaxial cable and twisted-pair wire. Hundreds of fibers can be bundled into a cable no thicker than the lead in any ordinary pencil and maintain excellent signal-carrying capabilities as well. Accompanying this tremendous size reduction is a

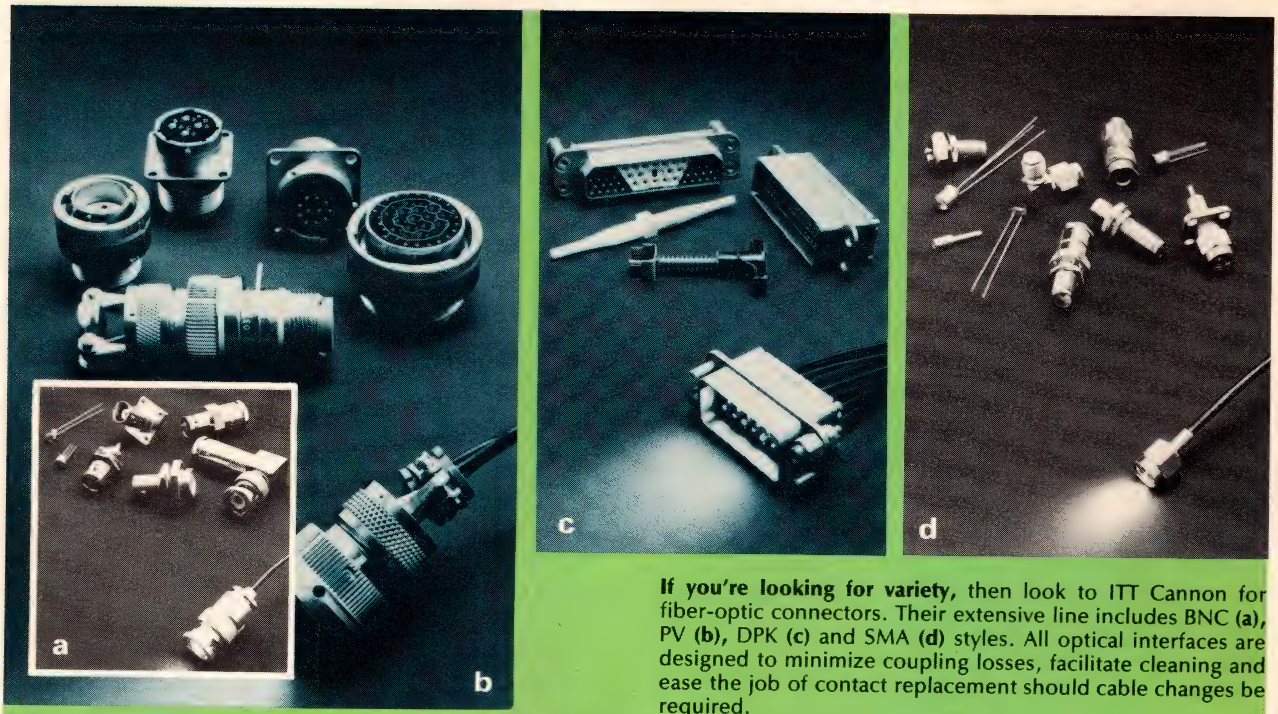
Optimum packing fraction and simplified end-polishing were prime considerations in the design of AMP's new fiber-optic connectors. The termination mates with a light source, detector or multiposition connector.



ZIF invades the world of backplane interconnects with the QIKLATCH series. Burndy uses a locking latch/take-up spring combination to provide electrical and mechanical reliability.



No muss, no fuss could be the calling card of the FLATTAC™ line of flat-cable assemblies from Elco. Eliminating the need for stripping, welding or soldering, the flat conductor cables come complete with a choice of box-type, card-edge or solder-tab contacts for connecting directly to pc boards.



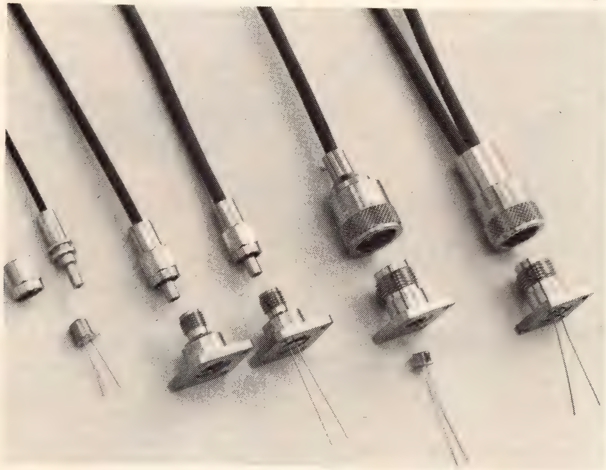
If you're looking for variety, then look to ITT Cannon for fiber-optic connectors. Their extensive line includes BNC **(a)**, PV **(b)**, DPK **(c)** and SMA **(d)** styles. All optical interfaces are designed to minimize coupling losses, facilitate cleaning and ease the job of contact replacement should cable changes be required.

corresponding reduction in weight.

"Additionally, fiber-optic cables provide immunity to stray RFI and EMI fields that can distort signals in metallic cabling. Finally, maximum security is provided because optical cables are virtually impossible to tap, and there is also no conventional RF emission, signal-coupling or cross-talk between fibers."

On-the-shelf and ready to go

Building on an established series of subminiature coaxial-cable connectors, Bunker Ramo's 905 Series of fiber-optic connectors will join optical bundles currently manufactured by Corning, DuPont, Galileo, Valtec, Poly-Optics, Pilkington and Rank. Although designed to accept photo transistors in large TO-5 cans, the receptacles in this line can, using inserts, handle LED's and other semiconductor devices packaged in smaller cases. The 905 series also includes straight cable plugs and in-line splices.



To help keep costs low, the basic design of Bunker Ramo's 905 Series of fiber-optic connectors is taken from their SMA coaxial-connector line. In addition to accommodating light sources and detectors, the 905 line will join all optical bundles currently manufactured by Corning, DuPont, Galileo, Valtec, Poly-Optics, Pilkington and Rank.

To minimize costs, the basic connector design is taken from the company's SMA coaxial-cable connector line. The principal design change occurred in the connector body, which now has an outer diameter of 0.25 in. and a max. cable opening of 0.156 in. in its solid-brass backend. The mating-probe end is then drilled to optimize the specific bundle's packing fraction (the ratio of total cross-sectional core area to total cross-sectional array area).

If breadth of product line is any barometer, then ITT Cannon appears "bullish" on fiber optics. A devotee of the metal-shell philosophy, Cannon offers connectors in BNC, PB, DPK and SMA styles. Spanning the spectrum from the most stringent military environmental requirements to the demanding cost restraints of consumer applications, Cannon's connector offerings include complete lines of source-to-fiber, fiber-to-fiber and fiber-to-detector connectors. All units assemble and disassemble easily, and all optical interfaces may be cleaned as necessary without total disassembly of the connectors.

AMP, a plastic-connector champion, offers a termination that accommodates a wide variety of fiber-optic bundles, provides optimum packing fraction and simplifies end-polishing. Termination capability also includes splice bushings, bushings that can house either a light source or photosensor, and multiposition connectors.

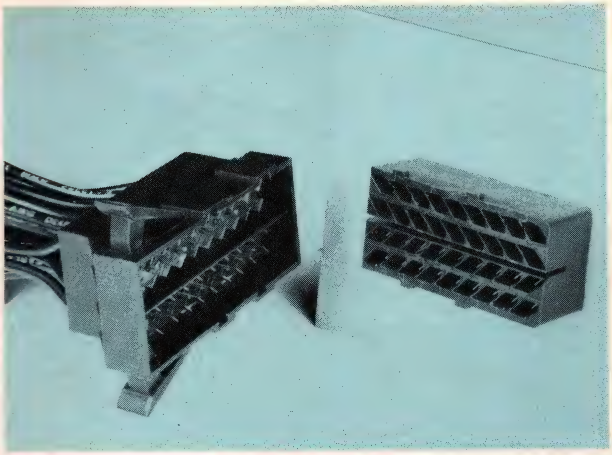
Dry-splice insertion loss (two terminations face-to-face in a splice bushing) is approximately 3 dB. Depending on the type of bundle terminated, insertion loss is about 2 dB with an index-matching, coupling-medium fluid.

During termination (and when connected), the resilient nose of the thermoplastic ferrule compresses radially, compacting the fibers into a min.-diameter bundle on the centerline of the termination. This feature lets the termination absorb the tolerances normally associated with the number and diameter of fiber in a bundle, and thereby provides a superior packing fraction.

Promising today, but what about tomorrow?

The early efforts to achieve standardization lists high among the most promising signs in the fiber-optics field. Manufacturers in all facets of the technology—cables, electro-optical devices and connectors—are currently addressing this task. The connector industry has readily adopted the fiber-optics philosophy: Rather than take an old "wait-and-see" attitude, many connector manufacturers now concern themselves with this technology, though still in its development stage.

Cost and weight advantages of plastic-bodied connectors are embodied in the CPC family from AMP. Molded from flame-retardant thermoplastic, the connectors have built-in contact protection and are available in both sealed and unsealed versions for panel or free-hanging applications.



When you need a ZIF for cable-to-panel interconnects, try the 4346-N from Molex, Inc. Available with 16-, 24- or 36-circuit capacity, the units offer long life, a choice of crimp or pc-tail terminals, a 94V-O-rated housing and either pre-tin or selective gold-over-nickel-plating options.

Circulars—good designs never die

Since they've been around so long, it's natural to assume that nothing new in the area of circular connectors could possibly exist. Quite the contrary—a good deal of activity has occured in product refinements and modifications, but new design techniques in polymer retention as well as contact manufacturing are also in evidence. Many totally new lines have appeared on the market, including one family of all-plastic devices.

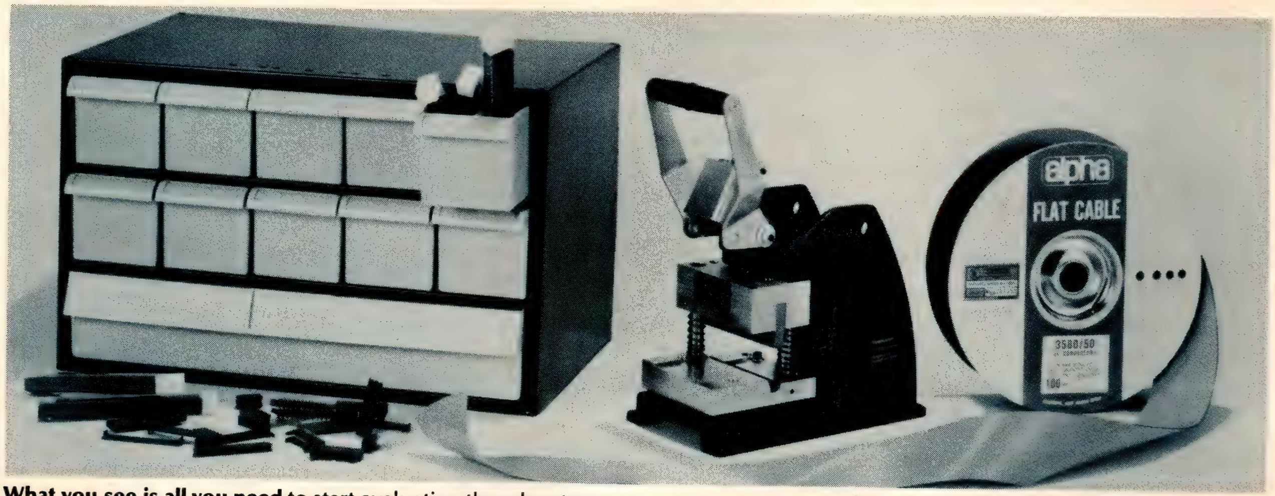
Why all this activity in circulars? The answer (which AMP used to justify the introduction of their CPC circular line), is quite simple: The circular connector is the single most widely used multipin connector in the electrical and electronic industry. And the reasons for this preeminence are sound.

When compared to other geometric shapes, the circular has an extremely favorable weight-to-strength ratio. The standard rotating-coupling mechanism of circulars eliminates the need for either separate jackscrew hardware or additional mechanical devices to compensate for greater mating and unmating forces as contact densities increase. Versatility is probably their most attractive advantage; they can be modified to a considerable extent without altering their standard characteristics.

MIL on the left, commercial on the right

The shopping list of new circular offerings is a rather mixed bag. The Tri-Start connector from Bendix operates without lockwiring under severe vibration and temperature conditions. A unique threaded coupling allows rapid complete mating in three quarters of a turn, with self-locking and resultant anti-decoupling capability.

To minimize potential contact damage, the



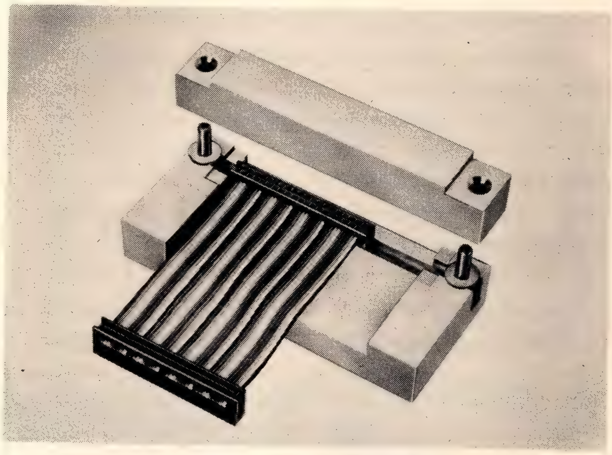
What you see is all you need to start evaluating the advantages of flat-cable interconnect systems. The FCT-80 designer's kit from Alpha Wire Corp. includes an assortment of 57 styles of connectors, a 100-ft reel of 50-conductor flat cable and a bench press with universal adapter.

Tri-Start is scoop proof and provided with universal holes for front- or back-panel mounting. Common inserts, contacts and application tooling extend the proven advantages of MIL-C-38999 to the Tri-Start design.

Burndy Corp. exemplifies the new contact-manufacturing techniques cited earlier. They've designed a contact line (Trim Trio) that works as well in their hard- and soft-shell rack and panel connectors as in their METALOCK BANTAM line of miniature circular connectors. Units in this latter line have a high-strength plastic body with a durable, metal bayonet-coupling/quick-disconnect feature, providing reliable mating and unmating without stress problems.

Using the TRIM TRIO contact system allows the choice of intermixing or strip-formed, machined or subminiature coaxial contacts, and achieves both versatility and economy. All eight shell sizes in the line have polarization keys and keyways to facilitate blind coupling; the aluminum coupling rings are fitted with steel springs to insure positive locking.

Enhanced insulation-displacement action is a prime feature of Berg's new Quickie pc-board connector. Available with from 10 to 50 contacts, the connectors may be mass-terminated to round-conductor flat cable before or after they've been wave-soldered into pc boards.



Second-source insurance is comforting to designers, and that's just the kind of policy Vector Electronic's P187 terminating fixture provides. Unlike proprietary units which handle only certain plugs, the P187 accommodates all female IDC plugs from Vector, AMP, Alpha, Ansley, Berg, CW Industries, 3M and Stanford Applied Engineering.

TRW/Cinch has developed a new series of circular connectors designed for pc boards and flexible circuits. Designated the Nuline 901 Series, they offer high contact density that makes them particularly useful in multilayer boards.

Up to 85 size-22 contacts can fit in a number-18 shell insert. Other sizes in the line are available for insert arrangements of 12 to 155 contacts. Used with flexible circuits, the connectors are supplied with a nylon pad for more secure contact. Featuring terminal lengths ranging from 1/16 to 1/4 in., the connectors in this series conform to the electrical, mechanical and environmental specifications of MIL-C-81511.

Is the circular world going plastic?

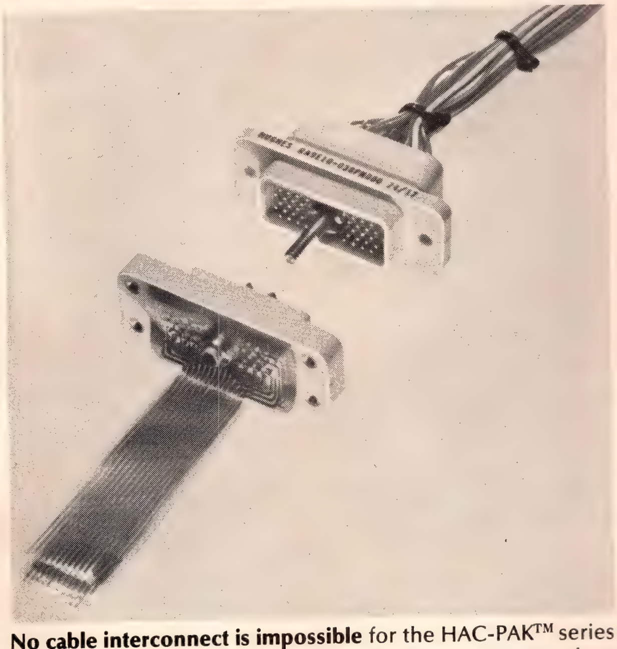
Recent product introductions seem to indicate a "yes" answer. One good example, AMP's all-plastic CPC line, satisfies the numerous industrial and commercial applications that require better performance than that of the soft-shelled connectors used in the appliance industry—but do not need the expensive metal-shell units designed for military applications.

Patterned after MIL-spec connectors, the CPC units have bodies and back-shell strain reliefs made from glass-filled nylon, and a coupling ring of a resilient thermoplastic. Four shell sizes (11, 13, 17 and 23) currently form the basis of the family. This size range allows for connectors with from 3 to 63 contacts, available in ratings of 7.5, 13 and 35A.

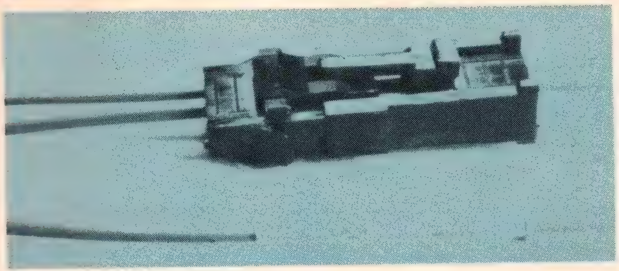
A skirt which extends from the mating face and completely encircles the contacts protects those in the receptacle housing. The skirt's five polarization keyways further enhance contact protection. Available in both sealed and unsealed versions, the CPC family is both UL-recognized and CSA-approved.

An even more significant "trend-to-plastics" indicator is the increasing popularity of polymer-retention systems. While Bendix, Cinch and Deutsch number among those currently offering polymer-type connectors, the Amphenol Div. of Bunker Ramo Corp. leads in breadth of product line. Merlin II, a most recent addition to their line, is a family of MIL-standard, high-density subminiature connectors.

With a total offering of 56 insert arrangements to both MIL-C-38999 Series I and II, this family of rear-release, crimp, removable-contact designs includes insert configurations in a complete selection of shell styles and contact sizes. All components are fully intermateable, interchangeable and intermountable with existing connector configurations.



No cable interconnect is impossible for the HAC-PAK™ series of subminiature connectors from Hughes. Designed to simplify the connection of round-to-flat, flat-to-flat or round-to-round cables, they come with three contact types: crimp-removable rear-release (nonenvironmental, environmental or potted), RFI/EMI fixed filter and fixed solder tail.



Versatility leads to economy and this leads you to the QIKMATE line of connectors from Burndy. Reasoning that "if it works—why not use it," Burndy has taken a standard low-cost, soft-shell connector body, added a fourth design to their TRIM TRIO contact system and come up with a highly reliable fiber-bundle connector.

The wide variety of insert configurations on the market includes versions ranging from a size-8 shell with three contacts to a size-25 shell with 128 contacts. Four contact sizes (22D, 20, 16 and 12) are available, as well as appropriate insertion/removal tools.

Rounding out the world of circulars

We've catalogued rather full-line product introductions above, but other activity in the circular field exists. Viking Industries, for example, has developed a connector that can be mated/unmated under full power with the device underwater. This unit is not restricted to marine applications only, however.

AMP speaks of approaches under development for microphone connectors that will bring IDC contacts into the small circular-connector field. This technology could perhaps reflect into other circular-connector designs where low cost and maximum production speed are required.

ITT Cannon has modified basic design concepts to effect customer economy, as well as designs for new applications in new markets such as automotive and off-road equipment. Further, their new environmental connector embodies many design concepts from old connectors—wire-sealing from standard-MIL connectors, interfacial-sealing from underwater types, and materials from standard circulars.

So despite its age, the circular connector field seems ripe with innovation and new design. Probably the most important trend is that of a new image. No longer can the circular be considered a MIL connector; from the standpoint of economics, it has definitely gone commercial.□

Article evaluation: Please circle one on R.S. card.
Read Some—No. 303 Read Most—No. 304

Connector-systems Directory

To help you get needed information, we've listed companies by product categories, then provided a combined listing arranged alphabetically with addresses and phone numbers. We wish to thank these manufacturers for their cooperation in the preparation of this report.

CIRCULAR

Alden Products Co.
AMP Incorporated
Amphenol Connector Systems
Appleton Electronics
Bendix Corp.
Burndy Corp.
Cole-Hersee Co.
Control Data Corp.
Dale Electronics, Inc.
Detoronics Corp.
Ercona Corp.
General Connector Corp.
Gulton Industries, Inc.
Hoffman Engineering Corp.
Hughes Connecting Devices
Hypertronics Corp.
ITT Cannon Electric
Kings Electronics Co.
Lemo USA, Inc.
Malco/A Microdot Co.
Matrix Science Corp.
D. G. O'Brien, Inc.
Stanford Applied Engineering
3M Company
TRW/Cinch Div.
Viking Industries, Inc.
Waldom Electronics, Inc.
Winchester Electronics

FIBER OPTIC

American Optical Corp.
AMP Incorporated
Amphenol Connector Systems
Burndy Corp.
Deutsch Co.
Dyonics, Inc.
Electro Optical Industries
IEE, Inc.
ITT Cannon Electric
Mass Flex Research, Inc.
Master Specialties
Sealectro Corp.
Spectronics, Inc.

FLAT CABLE

Airborn, Inc.
Alpha Wire Corp.
AMP Incorporated
Amphenol Connector Systems
Amtronics, Inc.
Ansley Electronics Corp.
AP Products, Inc.
Aries Electronics, Inc.
Augat, Inc.
Berg Electronics
Burndy Corp.
Continental Connector
CW Industries
Hugh H. Eby Co.
Elco Corp.
Ercona Corp.
Excel Products Co., Inc.
Flex-Link Products, Inc.
GTE Sylvania Inc.
Hughes Connecting Devices
ITT Cannon Electric
E. F. Johnson Co.
Kings Electronics Co.
Malco/A Microdot Co.
Matrix Science Corp.
Methode Electronics, Inc.
National Connector
Robinson-Nugent, Inc.
Spectra-Strip Corp.
Stanford Applied Engineering
Star Tron Corp.
Teledyne Kinetics
Teradyne Components, Inc.
Texas Instruments, Inc.
3M Company
TRW/Cinch Div.

ZIF

AMP Incorporated
Bendix Corp.
Burndy Corp.
Dale Electronics, Inc.
GTE Sylvania, Inc.
ITT Cannon Electric
Molex, Inc.
National Connector
Textool Products, Inc.

Connector Manufacturers

Airborn, Inc.
4321 Airborn Dr.
Addison, TX 75001
(214) 233-2000

Alden Products Co.
117 N. Main St.
Brockton, MA 02401
(617) 583-0160

Alpha Wire Corp.
711 Lidgerwood Ave.
Elizabeth, NJ 07207
(201) 925-8000

American Optical Corp.
14 Mechanic St.
Southbridge, MA 01550
(617) 765-9711

AMP Incorporated
449 Eisenhower Blvd.
Harrisburg, PA 17105
(717) 564-0101

Amphenol Connector Systems
900 Commerce Drive
Oak Brook, IL 60521
(312) 986-2700

Amtronics, Inc.
247 27th St.
Brooklyn, NY 11232
(212) 768-9300

Ansley Electronics Corp.
3208 Humboldt St.
Los Angeles, CA 90031
(213) 223-2331

Appleton Electronics
1701 Wellington Ave.
Chicago, IL 60657
(312) 327-7200

AP Products, Inc.
Box 110
Painesville, OH 44077
(216) 354-2101

Aries Electronics, Inc.
Box 231
Frenchtown, NJ 08825
(201) 996-4096

Augat, Inc.
34 Perry Ave.
Attleboro, MA 02703
(617) 222-2202

Bendix Corp.
Sherman Ave.
Sidney, NY 13838
(607) 563-9511

Berg Electronics
York Expressway
New Cumberland, PA 17070
(717) 938-6711

Burndy Corp.
Richards Ave.
Norwalk, CT 06856
(203) 838-4444

Cole-Hersee Co.
20 Old Colony Ave.
South Boston, MA 02127
(617) 268-2190

Continental Connector
34-63 56th St.
Woodside, NY 11377
(212) 899-4422

Control Data Corp.
31829 W. Latienda
Westlake Village, CA 91361
(213) 889-3535

CW Industries
550 Davisville Rd.
Warminster, PA 18974
(215) 355-7080

Dale Electronics, Inc.
Box 180
Yankton, SD 57078
(605) 665-9301

Detoronics Corp.
10660 E. Rush St.
South El Monte, CA 91733
(213) 579-7130

Deutsch Co.
700 Hathway St.
Banning, CA 92220
(714) 849-7844

Dyonics, Inc.
71 Pine St.
Woburn, MA 01801
(617) 935-5900

Hugh H. Eby Co.
4701 Germantown Ave.
Philadelphia, PA 19144
(215) 842-3000

Elco Corp.
2200 Park Pl.
El Segundo, CA 90245
(213) 675-3311

Electro-Optical Industries
Box 3770
Santa Barbara, CA 93105
(805) 964-6701

Ercona Corp.
2492 Merrick Rd.
Bellmore, NY 11710
(516) 781-2770

Excel Products Co., Inc.
401 Joyce Kilmer Ave.
New Brunswick, NJ 08903
(201) 249-6600

Flex-Link Products, Inc.
1923 First St.
San Fernando, CA 91340
(213) 365-9355

General Connector Corp.
81 Bridge St.
Newton, MA 02158
(617) 244-5706

GTE Sylvania Inc.
RD2 Box 29
Titusville, PA 16354
(814) 589-7071

Gulton Industries, Inc.
6400 Roland St.
Buena Vista, CA 90621
(714) 523-3480

Hoffman Engineering Corp.
183R Sound Beach
Old Greenwich, CT 06870
(203) 637-1719

Hughes Connecting Devices
17150 Von Karman Ave.
Irvine, CA 92714
(714) 549-5701

Hypertronics Corp.
154 Great Rd.
Stow, MA 01775
(617) 897-3236

IEE, Inc.
7720 Lemona Ave.
Van Nuys, CA 91405
(213) 787-0311

ITT Cannon Electric
666 E. Dyer Rd.
Santa Ana, CA 92702
(714) 557-4700

E.F. Johnson Co.
299 10th Ave. S.W.
Waseca, MN 56093
(507) 835-2050

Kings Electronics Co.
40 Marbledale Rd.
Tuckahoe, NY 10707
(914) 793-5000

Lemo USA, Inc.
2015 Second St.
Berkeley, CA 94710
(415) 548-1966

Malco/A Microdot Co.
12 Progress Dr.
Montgomeryville, PA 18936
(215) 628-9800

Mass Flex Research, Inc.
37 Whitcomb St.
Waltham, MA 02154
(617) 899-7735

Master Specialties
1640 Monrovia Ave.
Costa Mesa, CA 92627
(714) 642-2427

Matrix Science Corp.
435 Maple Ave.
Torrance, CA 90503
(213) 320-4040

Methode Electronics, Inc.
7444 W. Wilson Ave.
Chicago, IL 60656
(312) 867-9600

Molex, Inc.
2222 Wellington Ct.
Lisle, Il 60532
(312) 969-4550

National Connector
9210 Science Center Dr.
Minneapolis, MN 55428
(612) 533-3533

D. G. O'Brien, Inc.
500 Cochituate Rd.
Framingham, MA 01701
(617) 872-6596

Robinson-Nugent, Inc.
800 E. 8th St.
New Albany, IN 47150
(812) 945-0211

Sealectro Corp.
225 Hoyt St.
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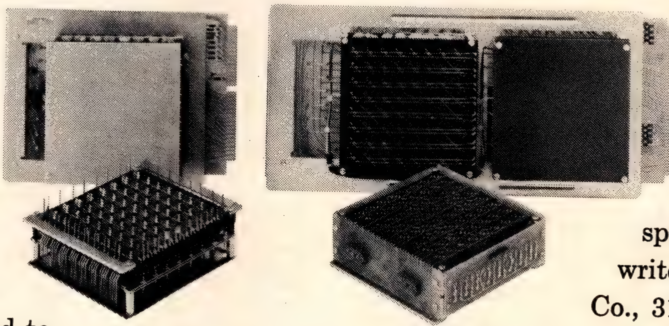

The PCB unit is compatible with conventional pre-wired card cage assembly techniques. The cable plug-in units mate with standard 9-pin in-line socket and 16-pin DIP jack terminations.

FOR MORE INFORMATION . . .

The new 969 Series is certainly worth finding out about. A New Mini Memory Matrix catalog is now available. Also available are two "TAR" (Technical Application Reference) publications: TAR-Clare Mini Memory Matrix and TAR-Clare Self-Latching Dry Reed Relays. For more specific design information, write G. Neeno, C. P. Clare & Co., 3101 W. Pratt Ave., Chicago, Ill. 60645. Phone: (312) 262-7700.

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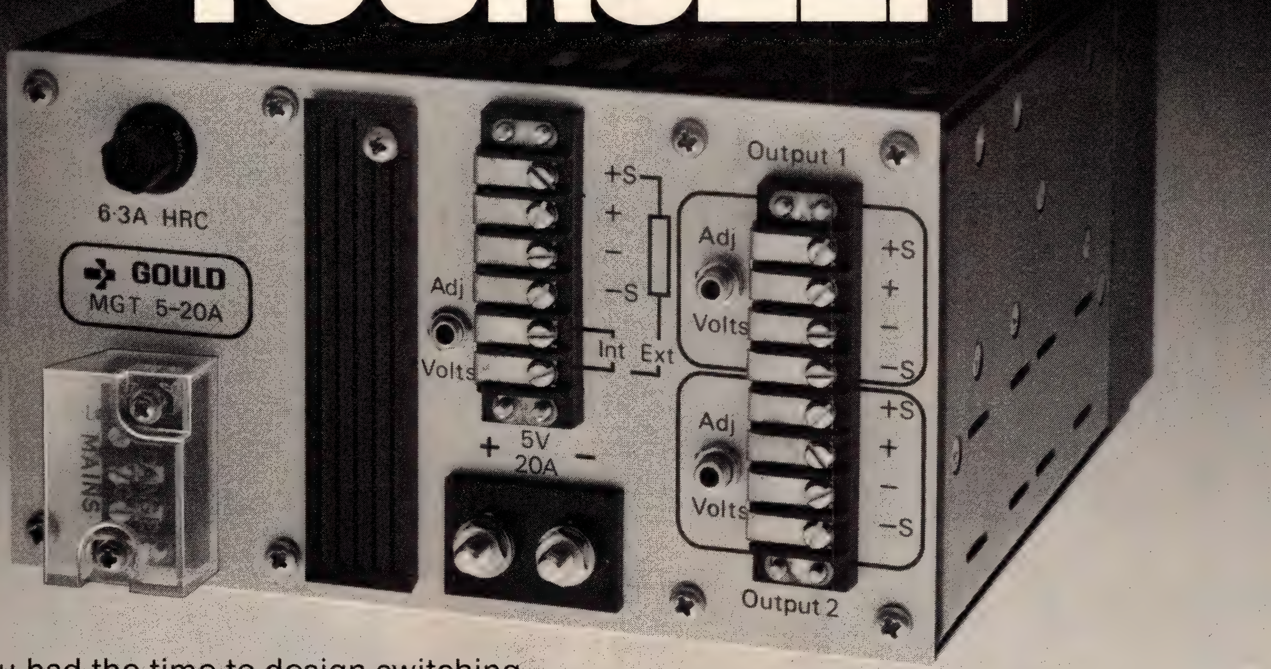

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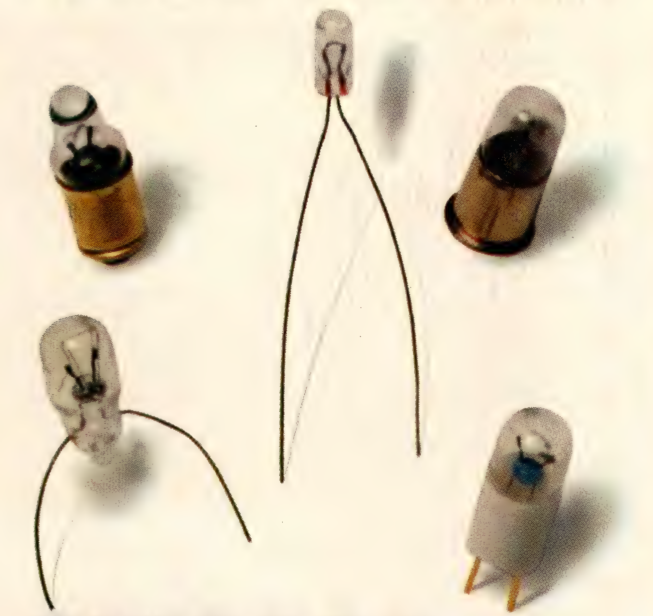

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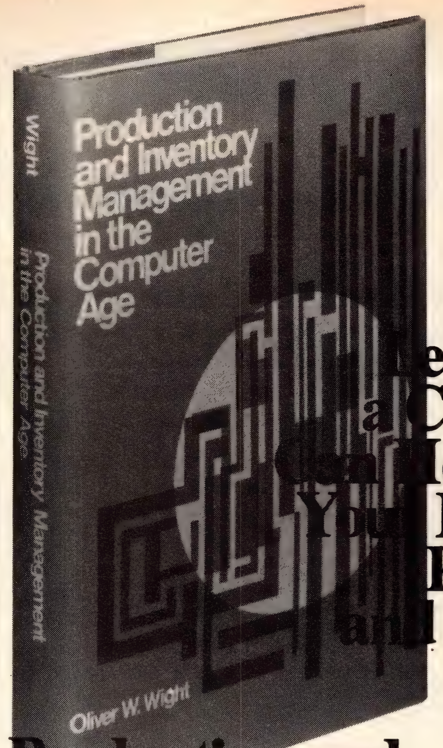
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Production and Inventory Management in the Computer Age
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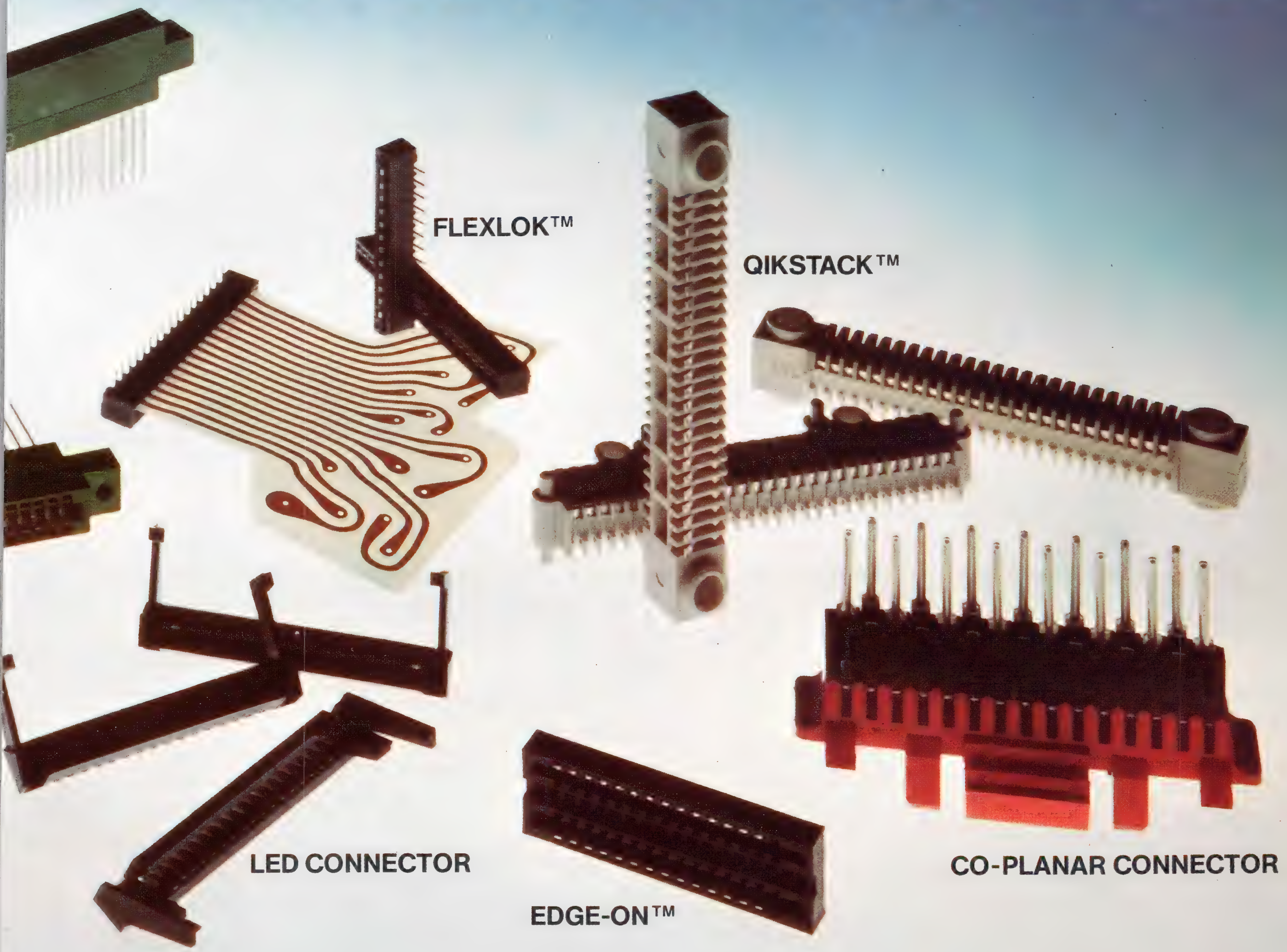

FIELD PROOF

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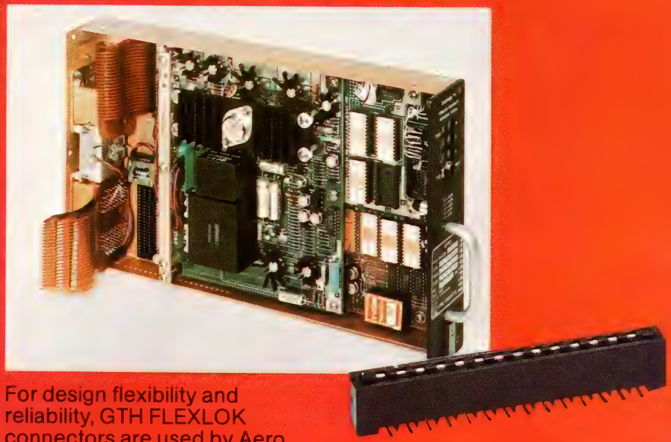

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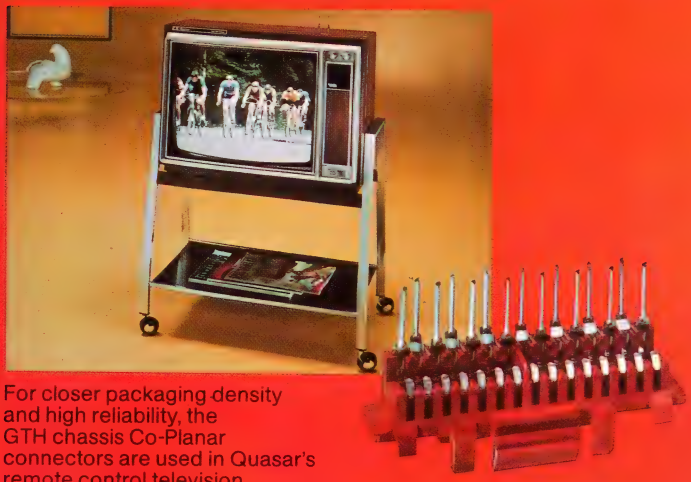

For closer packaging density and high reliability, the GTH chassis Co-Planar connectors are used in Quasar's remote control television.

With Burndy GTH connectors, you enjoy the performance characteristics of gold—without suffering its high cost. If that's too hard to believe, just study the performance comparison chart.

The secret behind the amazing performance of GTH is the use of high pressure plastic deformation to achieve a gas-tight, corrosion-free contact, and a contact geometry that provides an ingenious mechanical interlock to insure good metal-to-metal contact despite vibration or thermal expansion.

Burndy GTH contacts not only eliminate the need for gold in the connector, they eliminate gold in the mating component as well. You save both ways—without sacrificing performance or reliability.

Here's

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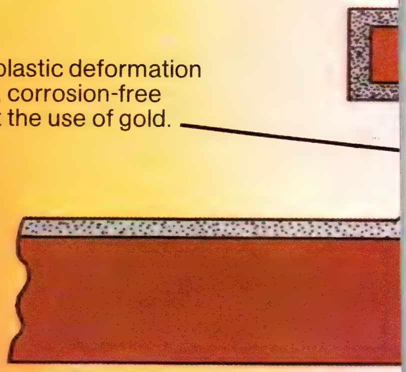
High-pressure plastic deformation forms gas-tight, corrosion-free contact without the use of gold.



ADVANTAGES OF GTH CONNECTIONS

- **Low cost, high reliability:** Helps you cut interconnection costs up to 33% and more—without sacrificing reliability.
- **Interchangeability:** May be used with existing gold, tin or solder-plated components with no loss in reliability.
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- **Ease of Installation:** Requires no special tooling or operator training. Installs like any ordinary connector.

Unbelievable? Send for more proof. Simply check the convenient Quick Response Card and we'll send you documented test data.

proof!

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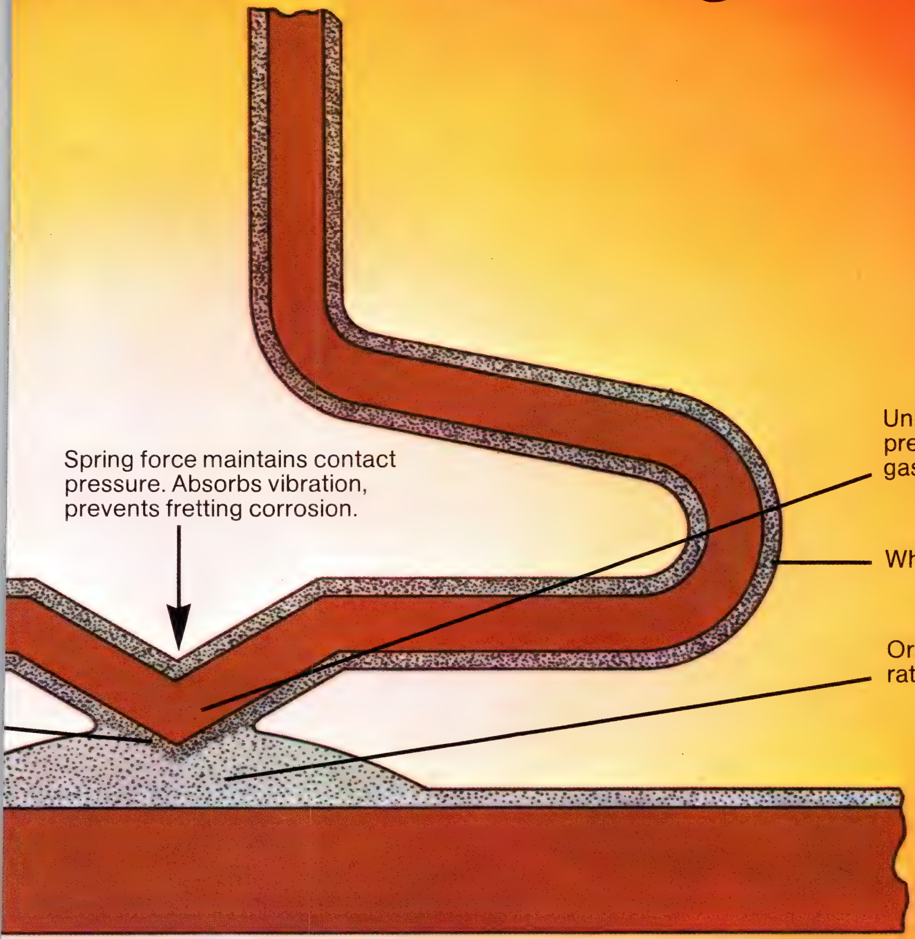


Spring force maintains contact pressure. Absorbs vibration, prevents fretting corrosion.

Unique contact geometry concentrates pressure at point of contact for gas-tightness.

Whisker-free tin-alloy plating.

Ordinary soft solder target rather than gold.

LABORATORY PROOF

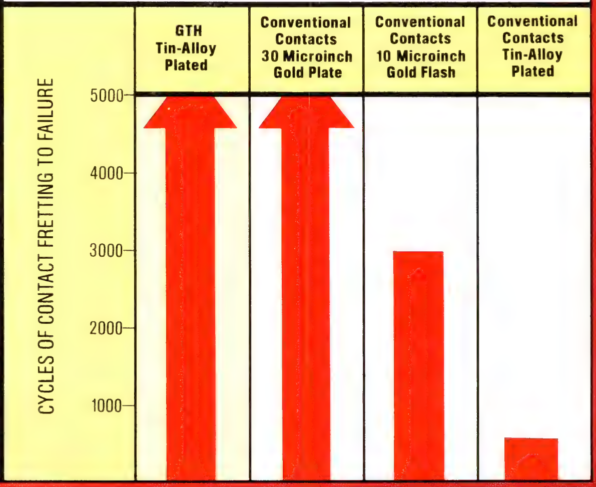
TYPICAL CONTACT RESISTANCE VALUES (Milliohms)

After Environmental Test, at Dry Circuit Levels.
(Range of Values Within 99.9% Confidence Level)

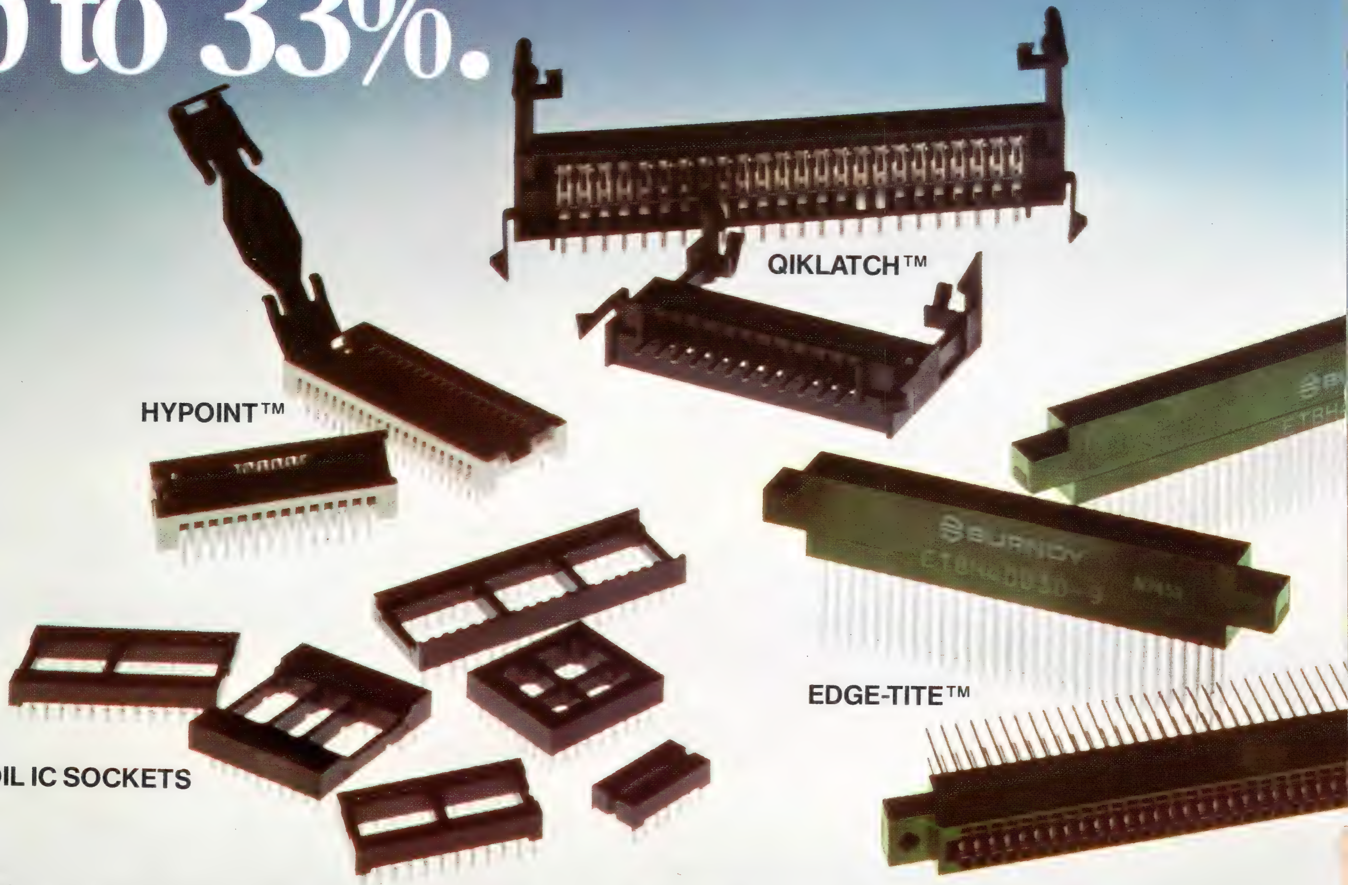
Environmental Test	GTH Contacts	Conventional Geometry Contacts			
	Tin-Alloy Plate	15 Microinch Gold Flash	30 Microinch Gold Plate	50-100 Microinch Gold Plate	Tin or Tin-Alloy Plate
Initial	4.0 - 6.0	4.5 - 13.3	4.5 - 8.6	4.4 - 8.3	4.1 - 12.0
Thermal Shock	4.0 - 8.6	6.0 - 15.0	5.0 - 8.0	5.2 - 7.2	6.0 - 15.0
Humidity	4.5 - 7.0	10.1 - 31.8	5.0 - 9.0	4.9 - 8.8	5.3 - 75.1
Industrial Atmosphere	4.0 - 6.0	10.9 - 20.3	5.0 - 20.0	5.0 - 13.0	28.7 Open Circuit
Gas Tightness	4.0 - 6.5	Not Applicable	Not Applicable	Not Applicable	4.0 Open Circuit
Thermal Cycling	4.0 - 7.0	8.5 - 15.5	5.0 - 10	4.6 - 9.0	4.0 Open Circuit
Durability	4.0 - 5.5 100 cycles	10.1 - 12.2 100 cycles	5.0 - 9.0 100 cycles	5.3 - 9.3 500 cycles	13.9 - 57.9 100 cycles
Vibration	4.0 - 5.5 5-500-5 Hz	9.0 - 15.0 10-55-10 Hz	4.0 - 8.0 10-2000-10 Hz	5.3 - 9.3 10-2000-10 Hz	4.0 - 15.0 10-55-10 Hz

IMMUNITY TO FRETTING CORROSION

Relative Lifetimes Under Accelerated Fretting Conditions
Without Lubrication



Burndy GTH connectors: Your golden opportunity to cut connector costs up to 33%.



Burndy GTH connectors are available in all types of designs for all types of applications. All of them are currently being used to help control connector costs by some of the best known names in the electronics field. Names like Quasar Electronics, Litton Industries, Honeywell, National Semiconductor, Dictaphone, and Wang Laboratories to name just a few. Use the convenient Quick Response card for more information on how GTH can help you keep your competitive edge. We'll send you data that's worth its weight in gold.

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CO-PLANAR solderless-wrap chassis connector in 15 positions on .156″ centers.

HYPOINT™ leadless IC receptacles in sizes from 24 through 48 positions.

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Designer—think "user" when you firm up that interface device

Clothing manufacturers survive only if their products fit well and please the user. There's a moral here for computer-room suppliers.

John Dinan, Raytheon Co.

Today's computer room is an anachronism. We've located a 20th-century computing device in a noise environment that resembles the 19th-century textile mill. Equally hard to reconcile, the operator of this equipment must work with a control device (e.g., keyboard) that was designed without considering specific human digital skills—or even the common features of the English language. Nor is that all. In many batch operations a 100-lb user must move tons of paper a week to and from these "marvels."

Designers could greatly improve computer-system productivity if they would just pay more attention to points of operator-machine contact that affect the speed and quality of throughput.

Pointing a finger at a problem

The primary operator interface is the keyboard, and an ordinary typewriter keyboard presents a good example of how operator-machine interaction can affect throughput.

As early as the 1930's, A. Dvorak devised a keyboard that based finger work load on such hard data as finger strength and maximum tap rates. Finding that 35 digraphs (2-letter combinations) account for half of the keyboard tasks, he designed his improved keyboard to permit a maximum number of successive movements by fingers of the opposite hand or by nonadjacent fingers, and maximum use of "home-row" keys.

Dvorak's results were, and still are, impressive. His keyboard has produced operator speeds of 200 words/min. while the record for a standard keyboard stands at approximately 160 words/min.

Well, designers may not be sufficiently adventurous to use a Dvorak keyboard, but their choice of special-function keyboards is more difficult to understand. By a ratio of 5:1, they select the adding-machine layout **(Fig. 1b)** over the telephone arrangement **(Fig. 1a)**. Yet this choice seems illogical in view of the latter's long-demonstrated and statistically significant superiority based on time and error criteria.

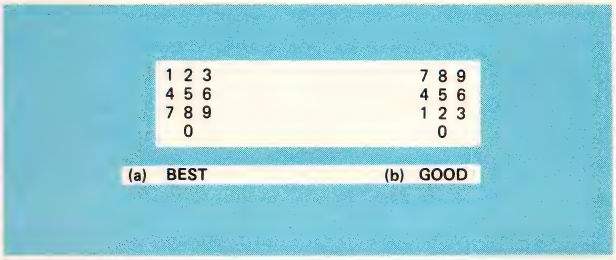

Fig. 1—It only makes sense to use a keyboard design that is faster to use and produces fewer errors, right? Then why do the designers choose the adding-machine layout **(b)** over the superior telephone arrangement **(a)**?

Why be concerned with operator-keying errors? Because they reduce throughput across four time segments: the original keying of the message, the system-error detection, the display of error to the operator and the rekeying of the message.

Selecting or designing hardware to reduce such errors requires attention to the areas of standardization, safety and operator efficiency/comfort, so let's discuss each in turn.

Standardization pays off

If your equipment is used with other I/O devices, all keyboard layouts should be compatible. An operator (perhaps a touch typist) can then switch from terminal to ASR to keypunch without the confusion and error rates that result when two or more varieties of keyboards are used.

Many other system areas can benefit from standardization. All major items of equipment in a

◀*For more information, Circle No. 47*

system should have common controls, labeling, abbreviations, arrangement schemes and control-panel layouts for common functions. This holds for the CPU, line printer, card punch, card reader, tape transport, disc drive, and for mainframe items.

Behind all this standardization is the psychological principle that people have a tendency to repeat learned behavior. Therefore, a "clear" button on the I/O console should be the same physical item as a "clear" button on all other devices. It also should be in the same relative location on all the devices and have identical labeling. Minor violations of this principle can cause higher error rates, while major violations increase training costs.

Safety: OSHA's watching you

If your design requires the user to change such items as filters, lamps or ribbons—and if to do this he must access maintenance panels—these changes should be possible without his approaching high-voltage areas (above 70V) or moving parts. Each piece of equipment should be systematically evaluated against all operator hazards, preferably using an accessibility checklist such as that in **Fig. 2.**

Every "yes" in the "operator can access" column requires a "yes" in the "protection provided" column. Both protection and warnings are needed where a clearly (or potentially) hazardous condition exists that cannot be corrected by design.

Comfortable operators accomplish more

While operator efficiency and comfort are difficult to relate precisely to throughput, proper attention here will certainly increase total system efficiency.

If some type of work-flow analysis is completed—especially for batch operations—the following floor-layout objectives can be realized:

- Task-shared equipment should be equally accessible to all users.
- Nonusers should not have to pass near equipment that is not task-shared.
- I/O job tables should be located near the computer-room door.
- Similarly, it is preferable to locate forms/card-supply cabinets near the devices they support.
- Each unit of equipment should have a noise limit to which it will be tested.
- The principal operator work stations should permit comfortable seating (if console operations require >20 continuous min. at the console), or sit-stand operations (for <20 min.)—or both, if the user situation over three shifts calls for it. Hard, user-related, anthropometric data should govern the mechanical workplace design.

Designs based on such user-related requirements will achieve two significant advantages, each of which has a dollar value. First, user dissatisfaction and resulting engineering change procedures will be minimized. Second, the user will enjoy a safe, efficient work environment.

Ways to spend little but get big returns

A closer look at principal work-station hardware reveals that design features to enhance operator performance need not be expensive. For instance, if the console is used less than 20% of the time the operator is in the computer room, provide a sit-stand design option. Also, if the facility includes a large work station, locate shelf space to the operator's right side. Supply cable long enough to give the user some floor-layout options. And to make layout optimization easier, fit all movable pieces with 2-1/2-in. diameter Shepherd planetary-type casters with locks.

Again, designs to avoid if possible are those that require the operator to get behind panels for console maintenance. Further, most operators

Facts a designer should know

The range and variety of user data is virtually inexhaustible, but computer-room design research should investigate at least two major areas: application and personnel. Further, to be useful, this information must be carefully collected, assembled and analyzed.

Application information should include data on the number of shifts, and type of operation (batch, comm., etc., per shift) and the total equipment complement. Likewise, personnel data should include a computer-room organization chart, as well as the sex and age of the equipment operator and that operator's educational background.

The design impact of this application/personnel data shows up when design decisions depend upon certain user behavior. It helps answer such questions as whether to replace or clean filters; what need exists for access to maintenance panels; and how much familiarity should exist with a standard keyboard layout. For instance, a system designed for a 17-yr.-old user with a ninth-grade education working in a large batch operation could differ significantly from one where the user is a college-level engineer involved in a lab-type operation.

	OPERATOR CAN ACCESS		PROTECTION PROVIDED		WARNING PROVIDED	
	YES	NO	YES	NO	YES	NO
HIGH VOLTAGES						
OVER 500V						
70-500V						
30-70V						
GROUNDING						
RADIATION						
X-RAY						
RF						
RADIOACTIVE MATERIAL						
MECHANICAL						
MOVING PARTS						
HANDLING						
ACCESS						
SHARP OBJECTS						
INTERCONNECTIONS						
CRT IMPLOSION						
THERMAL						
PRESSURE						
WATER						
STEAM						
HYDRAULIC						
CHEMICAL						
EXPLOSIVE MATERIAL						
TOXIC MATERIAL						
IRRITATING MATERIALS						
FIRE						
OTHER						
NO EMERG. WARNING						
EXCESSIVE NOISE						

Fig. 2—Accessibility check list aids the systematic evaluation of designs for potential operator hazards.

have little actual use for operating manuals, so designers need not build a library-type shelf into the console. Instead, they should provide small cards with error messages for use during initial hands-on operator training.

Those I/O devices, the TTY and CRT

Some fairly simple, but important do's and don'ts apply to the TTY. For example, if the terminal is interactive, do color-code incoming and outgoing messages (2-color ribbon with color shift). Select the character-set/keyboard-type style to be uniform on keypunch and high-speed printers. Make ribbon changing a clean and simple task. Eliminate sharp edges or corners from enclosures. Provide a height adjustment for large (and small) body sizes to add to the overall ease of use. Finally, provide a platen that displays up to 60 lines of data, and design it so that the operator can write or erase on it.

Even alarm sources have their pluses and minuses. Pleasant "beep-type"audio alarms, instead of the strident AHRUGAH type, are much preferred.

CRT terminals seldom get the design attention they need to properly serve the user's demands. Some requirements—like physical features similar to those of the TTY device, and minimized reflections and glare from the display surface (which should be laid out perpendicular to the line of sight)—seem almost obvious. Others, more subtle, are probably apparent only to those who've spent much time with CRT terminals.

Among the less obvious points is that no hard-copy backup capability need be provided. Except for batch operators (who desire proof where and how a job bombed for their own protection, and so the programmer can be informed), hard copy is rarely used.

Regarding formatted messages, designers should carefully consider a scheme such as that of **Fig. 3.**

Cursors and joysticks have their preferred versions, too. Generally, using a box-shaped cursor with an isometric stick for cursor control proves best. The isometric stick has demonstrated superiority to the standard joystick or trackball in reliability, cost, positioning time and positioning accuracy.

Display software preferably should be of the "intelligent" interactive variety. It should lead an unsophisticated user to error-free results via the menu process (which requires less operator activity). The display itself should use upright characters, since most user surveys show them to be superior to slanted characters in both speed and accuracy of identification. Blinking and double-brightness options serve well for user-applications that require immediate attention.

Finally, display software should provide forms (where user-applicable) and protected fields, so the "right" information doesn't wind up in the "wrong" place.

Attacking the facility layout

All we've discussed so far comes together at the user's facility. Here the equipment layout is customarily based on the previous layout, cable lengths, cosmetic-arrangement criteria or all three. This combination then follows a Parkinson's Law of sorts for installation teams—that is, the equipment complement expands to fit the available floor space.

Designers can most easily establish a logical layout based on operator activity and equipment characteristics by using the following 5-step method:

1. Determine the kind of operation that will be performed on each shift (Batch, Comm., etc.); then ascertain the probable equipment complement and define both the probable per-shift manloading and each operator's duties (listed sequentially).
2. Set up a scale layout of available floor space, preparing scale models of both the computer equipment and the tape-, disc-, and forms-supply cabinets.

3. Attach a plexiglass overlay to one end of the floor sketch arranged so it can easily be lifted to move the scale models around.

4. Make a preliminary floor layout using the layout aids, and trace operator-to-equipment and operator-to-operator task links on the plexiglass overlay with a grease pencil.

5. Using the layout aids, modify the basic layout for the best possible compromise, taking into consideration all of the following points:

- Batch operators require physical access to card readers, tape stations, printers and card punches—all prolific sources of noise. Where trade-offs exist in equipment layout, make provision for a reasonable separation between the operator's console and these noise producers.
- Because disc units are used infrequently, they need not be close to the operator's console. When two operators will use them, separate the discs and arrange them for the convenience of both.
- When arranging time-sharing and communications systems, give prime space consideration to the operational use of noncomputer equipment such as data phones, ASR's and RO's.
- Locate forms-supply cabinets near the input/output devices to significantly reduce operator fatigue, especially in batch operations.
- Try to position disc- and tape-storage cabinets near the devices they support.
- Situate input/output job tables near the computer-room door (to keep noncomputer-room personnel out of the area). Simultaneously, try to keep them near the tape station, card reader and other input devices.
- If communication between operators is definitely required, arrange the computer-room layout to enhance this capability. Note that team activities, where task performance is dependent upon the interaction of two or more operators, are more common in the zone-type operation (where the operator is assigned to devices, rather than to following a job from beginning to end).

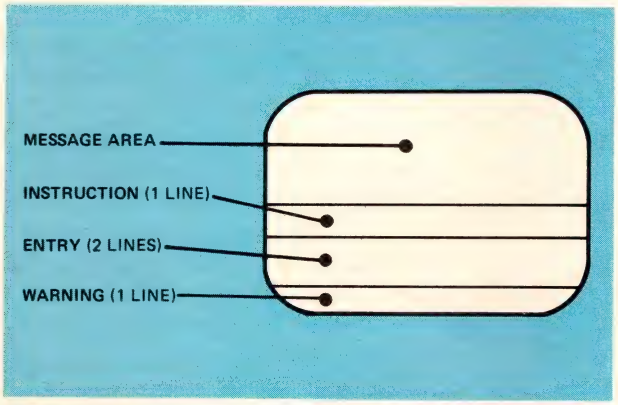

Fig. 3—Message-format scheme that a designer selects for a CRT display should put data in specific, easily recognizable areas.

The foregoing layout instructions and guidelines illustrate many typical user-type site-layout requirements. Designers should handle individual requirements by working-up the scale layouts in close consultation with user representatives and the senior member of the particular installation team.

One additional layout caution is in order. Be sure to isolate the operator's work station from noise sources such as air conditioners, high-speed printers, and card punches. After completion of the installation, make a noise survey and, using OSHA exposure criteria, set down recommended exposure durations if the results show noise levels in the lower 90-dB range. This protects operators and could shortstop a legal suit.

What would you do if you were the user?

A final key hint: The designer should try to place himself in the user's shoes. Collecting and applying user-requirement data serves three purposes: It provides a sound and sensible design rationale, it alerts customers that the designer is sensitive to their needs (a marketing plus!), and it can hint at measures needed to protect his creation from operator abuse, no matter how unintentional.

A few comments on the latter point are particularly important. Remember that a user is most interested in what a machine can do for him. This is the "rental car" syndrome. Ask yourself this: If you were two miles from the airport in a rental car and the "over-temp" light or the "oil" lamp came on, would you stop and miss your flight?

The message here is that a designer shouldn't depend on users to be interested in his equipment for its own sake. Therefore, he shouldn't "OR" overtemp sensors to a "warning" lamp that requests operator reaction. Rather, he should provide an automatic shutdown that also gives users advance warning so that they can protect their data.

Similar user-oriented thinking should apply to all hardware designs. Switches, for example, should be forced-limited, so they cannot be torn out by the roots (in the case of a pull switch). And although a console-shelf design ordinarily might not be stressed to support 250 lbs., realize that it just may be used as a chair on occasion.

So think user! That's the complete message. Carefully consider how the user can use, and abuse, your equipment. You'll buy a lot of goodwill and avoid much grief if you do. □

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Author's biography

John Dinan is senior human-factors engineer for Raytheon's Equipment Div., Sudbury, MA. He holds an MA from Boston Univ. and has also taken engineering courses at both George Washington Univ. and Northeastern Univ. John is a member of the American Psychological Association.

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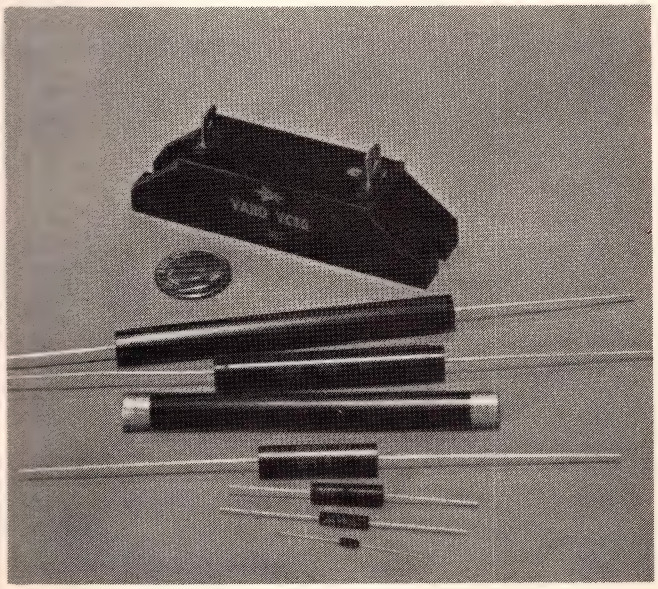

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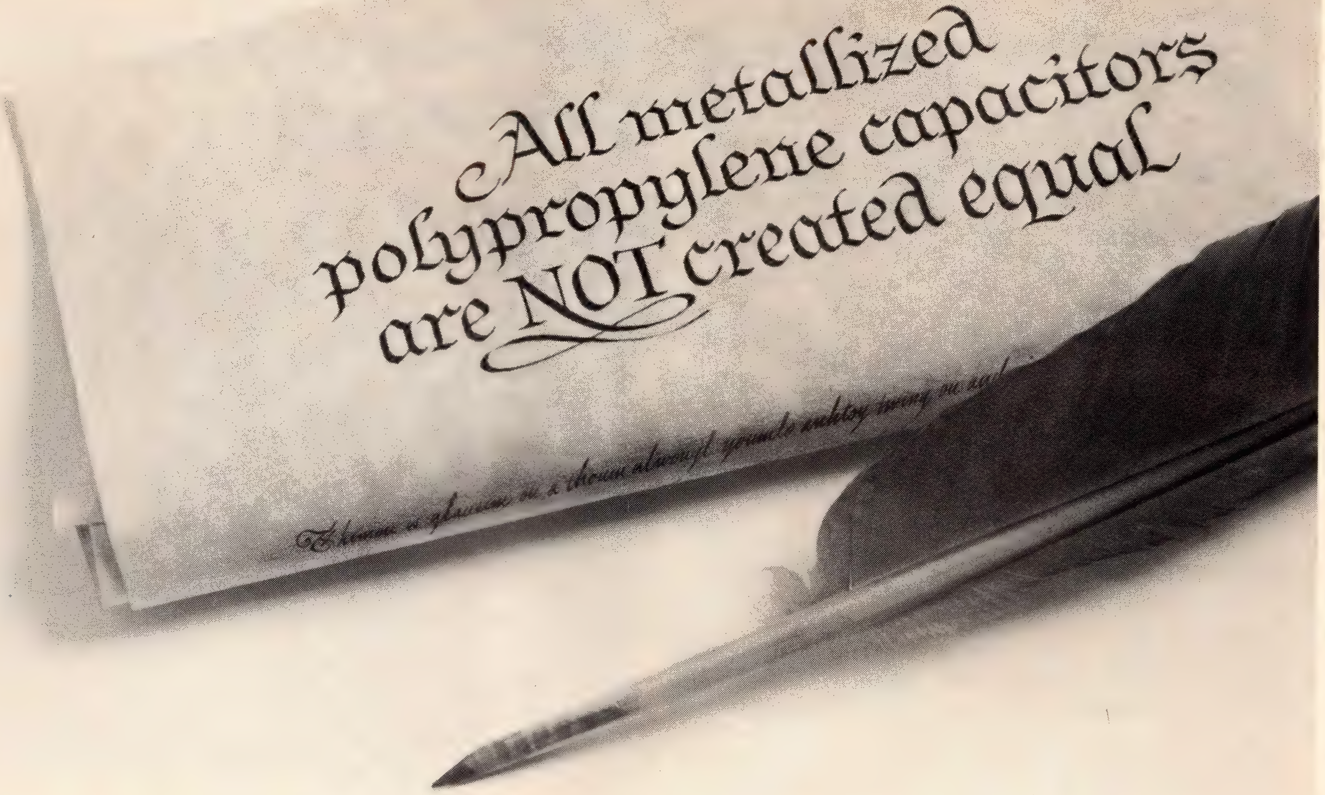

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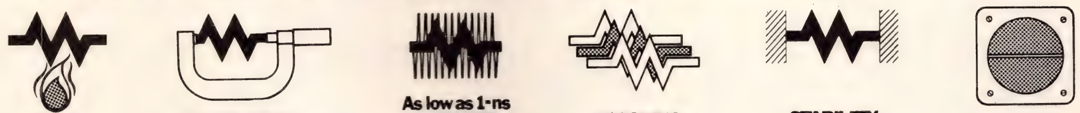

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Take a common sense approach to your µP application

EDN uses its hands-on experience to get acquainted with and apply the SC/MP µP as the basis for some down-to-earth advice.

Robert H. Cushman, Special Features Editor

Each new µP that EDN studies takes a considerable amount of continuous, concentrated, hands-on effort to gain sufficient knowledge to really use it creatively in OEM design. However, our repeated experiences have evolved a 5-step procedure that minimizes wasted time and energy. This article illustrates these steps by tracing our recent experiments with National Semiconductor's SC/MP.

However, first note that we advocate using simple, minimal hardware. Although essential to be able to program the system through a terminal such as an ASR-33, extraneous "bells and whistles" can be confusing to the point that they actually slow down learning. Of course, to use the terminal, your system must come with a resident MONITOR program. The ability to enter programs from a terminal, and then have the programs and the results typed out for "off-line" study, is critically important in speeding up your progress.

Step 1: Check—Is your µP a viable choice?

Before you invest your time in any µP, you must assess whether or not it is likely to be available for the next three to five years. Thus, we asked Floyd Kvamme, Vice President and General Manager of National Semiconductor's semiconductor division, whether National would develop an n-channel version of SC/MP. (We reasoned that this would be one good indication that National was serious about SC/MP.) Kvamme replied that National is indeed working on a NMOS version to come out sometime this fall.

(Basant Khaitan, one of the device designers for SC/MP, gave us a few pre-introduction details: The n-channel version will be a depletion-mode-load device needing a single 5V supply. It will run only slightly faster than the present PMOS machine, which takes a full 2 µsec for a machine cycle. The NMOS unit, however, should draw only 50 mA, meaning it will have only 1/4 the power consumption of the present 900-mW PMOS SC/MP. Chip size for the NMOS version will be moderately small, approximately 175 by 190 mils. Otherwise, the NMOS SC/MP will be identical to the present PMOS version, with the minor exception that a few of the bus controls will have opposite polarities.)

Step 2: Get a basic system running

Once you've judged that your µP choice will probably continue to be available in the foreseeable future, get a simple prototype working to obtain hands-on experience with the µP. The $99 SC/MP kit, widely available through National's distributors, proves excellent for this purpose. It packs enough hardware and resident software to enable you to acquire a good basic understanding of the machine, yet doesn't obscure the basic-system architecture by piling on a lot of options.

Unlike some of the µP kits on the market, you really can put this one together in a few hours. Moreover, the manuals supplied are quite adequate. EDN's kit worked the minute it was hooked up to the power supply and Teletype.

Fig. 1 shows our SC/MP system. We mount everything on a 24×14-in. board to easily store it away as a unit, yet have ready for instant use. This configuration also helps us develop a mental image of how much hardware complexity and component cost is involved—an important fact to consider when you start to plan products using µP's.

The photo calls out the components needed to complete the $99-kit system. We built the power supply with just two plastic 3-terminal regulators, plus some rather bulky old electrolytic capacitors.

The connector to the TTY is a printed-circuit, edge-connector arrangement that we've standardized to enable us to rapidly connect the TTY to any μP.

The most important hardware part of any μP breadboard is the "control panel." We recommend that you bring out to this panel all of the CPU and other system points possible, clearly labelling each. Install indicating LED's (with drivers where required) on the outputs and small switches where appropriate on the inputs. We use the techniques sketched in **Fig. 2** to do this quite rapidly and effectively.

Step 3: Study and use the MONITOR

Resident MONITOR's that come with μP systems like the $99 SC/MP kit (and the $185 Mostek F8 Survival Kit, the $350 Intel ADK-80 kit, the $159 Microcomputer Associates JOLT kit, etc.) perform two functions: Their intended use is as firmware to let you program and debug small programs from your TTY. However, they also provide "textbook examples" of good programming techniques on the μP. In the long run, this second, unofficial use can be the most important—especially for users new to programming.

The SC/MP "KITBUG" is about the simplest program of its type—its 512 bytes make it half the size of most competing MONITOR's. Because of its small size, KITBUG can respond to only three commands:

- T, for typing out continous hex dumps of memory;
- M, for altering memory locations; and
- G, for executing user programs in RAM.

Breakpoints are set by software, treating the return to MONITOR as a jump-to-subroutine.

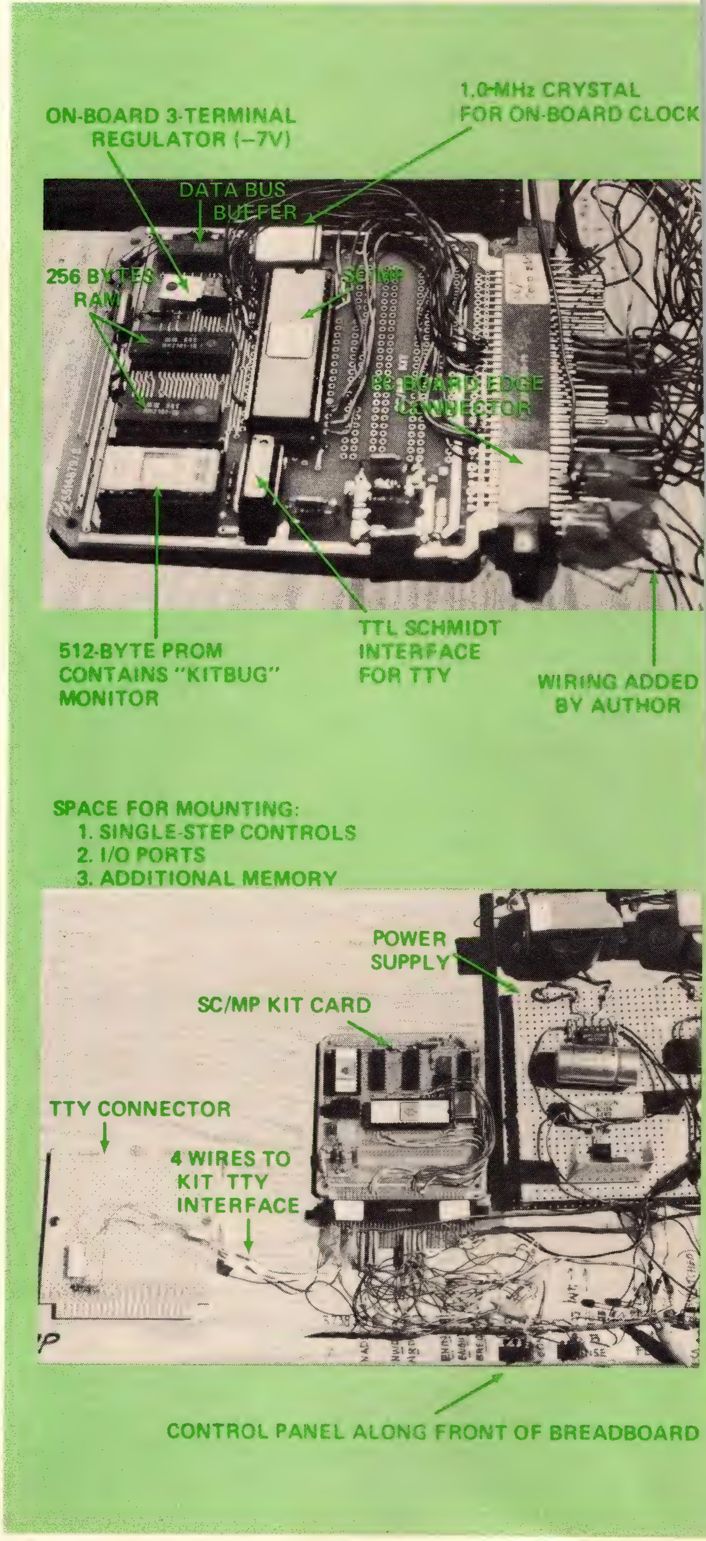
At first we resented working with such a minimal set of MONITOR commands. But with time, we've come to like their simplicity. With only these three uncomplicated commands, you should never need to refer back to the instruction manual.

We do wish, however, that KITBUG contained a set of commands to punch and read formatted tapes. Without this capability you cannot save programs off-line; to re-enter them you must retype them by hand. To get around this limitation, we developed a short 30-byte program that borrows from the KITBUG GECO subroutine **(Fig. 3)**. It will read TTY tapes into a designated area of memory, but it's a nuisance to load and takes up valuable space in our limited 256-byte RAM.

You can study and learn from the MONITOR programs in several ways. One, of course, is just to use the commands. However, you really don't absorb much that way.

A somewhat better approach is to try borrowing the MONITOR subroutines for your own application programs, as we did in **Fig. 3.** This at least makes you stop and determine how to call the MONITOR subroutine, as well as how to pass and receive data between your programs and these borrowed subroutines. To do this, you will need the printed assembly listing for the MONITOR found in most manuals.

But the real way to get the meat out of these MONITOR's is to single-cycle or single-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ON-BOARD 3-TERMINAL REGULATOR (−7V)
DATA BUS BUFFER
256 BYTES RAM
SC/MP
PC BOARD EDGE CONNECTOR
512-BYTE PROM CONTAINS "KITBUG" MONITOR
TTL SCHMIDT INTERFACE FOR TTY
WIRING ADDED BY AUTHOR
SPACE FOR MOUNTING:
1. SINGLE-STEP CONTROLS
2. I/O PORTS
3. ADDITIONAL MEMORY
POWER SUPPLY
SC/MP KIT CARD
TTY CONNECTOR
4 WIRES TO KIT TTY INTERFACE
CONTROL PANEL ALONG FRONT OF BREADBOARD

instruction step right through them, seeing for yourself in painful detail exactly what occurs at each step of the way. While this method entails such tedious chores as looking up the meaning of each instruction and checking the machine code to make sure you know which addressing mode is used, eventually you will completely understand how and why the computer responds to the code the way it does. Enough variety exists in even a simple monitor like KITBUG to show you how to program a wide variety of functions.

Step 4: Pick up the phone and ask

As we launch into each new μP, we often quickly find ourselves in a mire of puzzles. After a few weeks, a pile of notes on these problems gets so high that it's obviously time to reach for the phone and call for help.

In the case of SC/MP we were lucky, because National's Barney Hordos and Milt Schwartz had

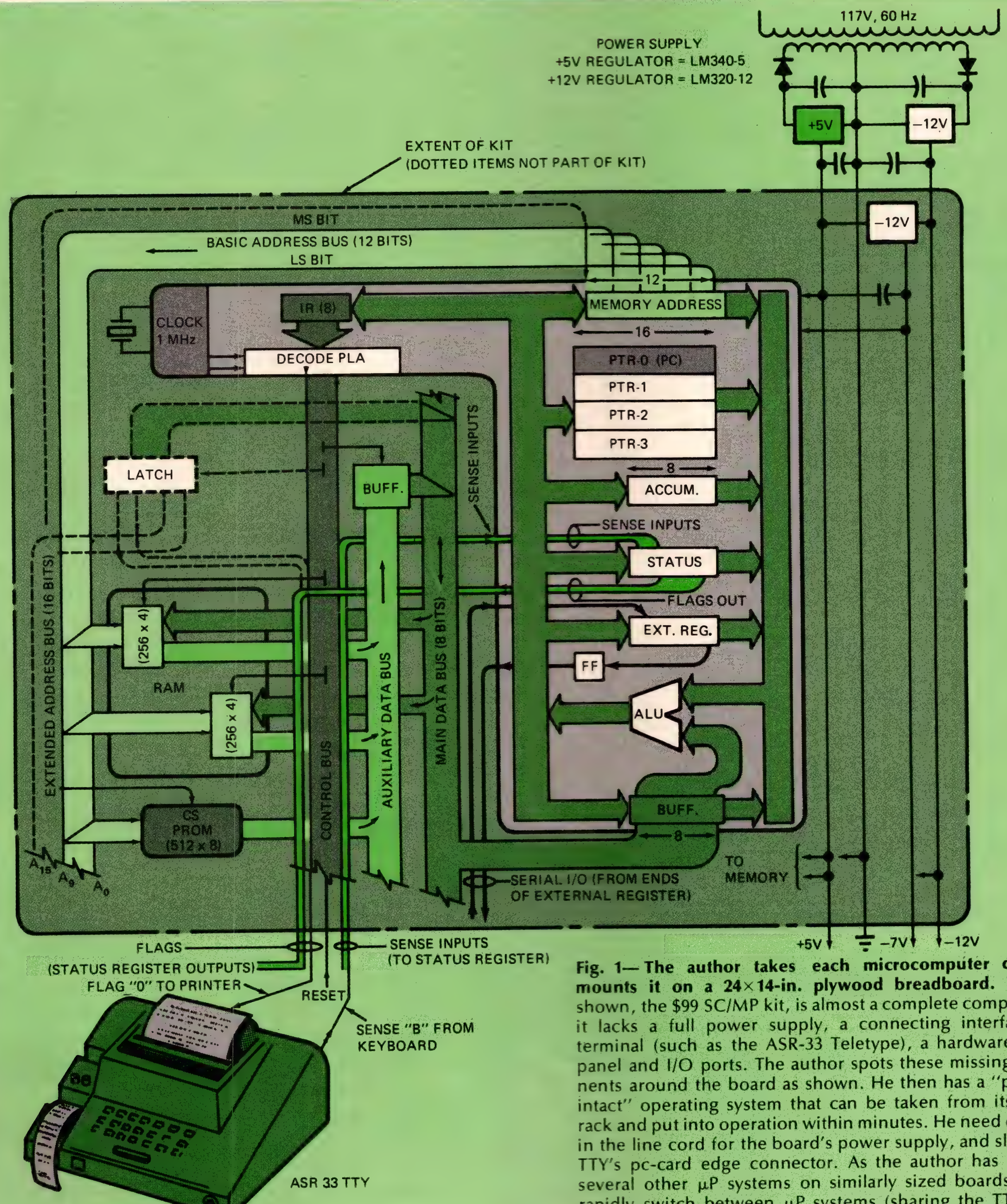


Fig. 1— The author takes each microcomputer card and mounts it on a 24×14-in. plywood breadboard. The one shown, the $99 SC/MP kit, is almost a complete computer, but it lacks a full power supply, a connecting interface to a terminal (such as the ASR-33 Teletype), a hardware control panel and I/O ports. The author spots these missing components around the board as shown. He then has a "physically intact" operating system that can be taken from its storage rack and put into operation within minutes. He need only plug in the line cord for the board's power supply, and slip on the TTY's pc-card edge connector. As the author has mounted several other μP systems on similarly sized boards, he can rapidly switch between μP systems (sharing the TTY) when comparing them for a given application. None of these boards will have a cost over $500.

no trouble in deciphering our confusions and suggesting solutions. Further, they invariably suggested additional programming tricks that we could also put to work immediately. In our opinion such service represents the best kind of μP support that any manufacturer can offer.

Two tricks for getting more out of kits

On the assumption that you'll have as much difficulty discovering some of the SC/MP tricks as we did, we'll pass on a couple. For example, did you know you can use the interrupt input to extricate SC/MP from any endless loops mistakenly placed in your application program? Of course, another escape is to use RESET, but that destroys the contents of all the CPU registers.

To implement this trick, you need a SPDT switch at the interrupt input that normally will hold the input off. Then you must place two instructions to set the interrupt enable bit in the status register at the beginning of your application program—a LDI (load immediate) into the accumulator and a CAS (copy accumulator to status) will work. Now, if your program hangs up in a loop and never reaches the breakpoint you put in, just press the switch on the interrupt input, and SC/MP will return to the MONITOR.

The MONITOR automatically loads its own return value into PTR-3 when it executes the "G" (GO) command to the application program, because the interrupt input forces the XPPC (PTR-3) switch to occur, without waiting for the 3F code that normally causes the switch. Therefore, you can next use the MONITOR to examine locations OFF7 and OFF8 where KITBUG saves application-program values for PTR-3. This will tell you where the SC/MP was when it was lost in the loop. Thus, you have an elementary "trace" ability, akin to the large $10k development systems.

The second trick concerns the borrowing of KITBUG subroutines. As we mentioned, the program in **Fig. 3** borrows the 62-byte GECO routine, and at the cost of practically no programming effort on your part, allows you to enter programs from either the TTY keyboard or the TTY paper-tape reader.

The main work in writing this program is to set up SC/MP's three pointer registers. We load PTR-3 to a point at one less than the starting address of GECO. (Because SC/MP's program counter increments just before fetching an instruction, all jumps must be to the location preceeding that from which the next instruction is to be fetched.) We aim PTR-2 at a free space in RAM, in case any of the KITBUG routines that expected to use PTR-2 as a stack are involved. Finally, we aim PTR-1 at the start of the buffer area in RAM that we want to hold the entered data.

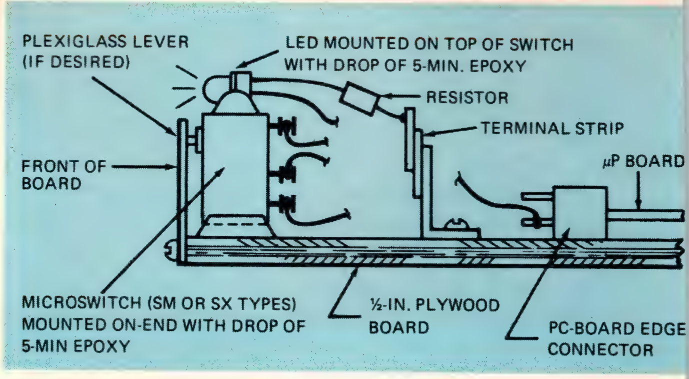

PLEXIGLASS LEVER (IF DESIRED)
LED MOUNTED ON TOP OF SWITCH WITH DROP OF 5-MIN. EPOXY
RESISTOR
TERMINAL STRIP
FRONT OF BOARD
μP BOARD
MICROSWITCH (SM OR SX TYPES) MOUNTED ON-END WITH DROP OF 5-MIN EPOXY
½-IN. PLYWOOD BOARD
PC-BOARD EDGE CONNECTOR

Fig. 2—Here's a quick-and-dirty way to mount control-panel switches and associated indicators along the front of a μP breadboard. You just place the components in a dab of quick-setting epoxy and solder on the leads. You will also want to write or type up an identifying label and epoxy that down along side or on top of the LED.

Our actual program consists of just a 3-instruction loop. The XPPC (PTR-3) instruction sends SC/MP to the GECO routine; the ST (PTR-1) instruction moves the ASCII character from the accumulator (where GECO left it) to the RAM buffer area; and the JMP (back to start) completes the little loop.

In operation, the borrowed GECO does all the work. It waits for a TTY to be hit, decodes the resulting serial transmission from the TTY and places the ASCII character so obtained in the SC/MP accumulator. Finally, it echoes back the serial transmission so that the TTY printer will type it. This handy bootstrap loader routine would be quite a programming chore for a newcomer to SC/MP. Before we leave it, note that the ST (store) instruction uses SC/MP's auto-indexing addressing mode, so it will automatically step the PTR-1 along to the next location in the RAM buffer. If you wish to pack two hex values from the keyboard into each RAM location—say you are using this to enter SC/MP programs—then you can write additional instructions at this point.

Step 5: Write a trial application program

As soon as possible after you begin working with a new μP, you should attempt to write short application programs, preferably ones that will produce results applicable to your needs. This will force you to realistically consider the machine in a design context and will sharpen your ability to evaluate it vs. other μP's.

One of the trial application programs that we've written automates telephone dialing **(Fig. 4).** It turned out to be a good example for the SC/MP kit because it needs only a small reed relay and a driving transistor for I/O hardware. The relay goes in series with one of the pair of telephone wires.

Normally closed, this is driven open at the required 10-Hz pulse rate by SC/MP to simulate the break pulses generated by the spring-driven return of the familiar manual rotary dialer. For preliminary trials, the SC/MP kit MONITOR can be used to permit the TTY to enter the numbers into the SC/MP RAM. Later you would probably want to devise a less expensive method for entering numbers.

In detail, the operating procedure for the system is as follows:

1. Use the TTY to enter numbers to be dialed into the designated RAM-buffer area. Use the MONITOR's "M" command to address the memory locations and enter the digits of the telephone number. This would not be too difficult during the initial trials because the "M" command is smart enough to ignore leading zeros, and automatically steps on to the next memory location, following the CR (carriage return) that finalizes the entry.
2. Use the MONITOR "G" command to direct the SC/MP to execute the dialing application program, after first loading the starting address of the dialing program into the dialing "save" address for the PC (program counter) in RAM. The application program then converts the previously entered telephone number into the proper sequence of dialing pulses and, via the driving transistor, opens the reed relay switch to send the dial command to the telephone system.
3. After the number has been completely dialed—all digits translated into their corresponding pulses—the program hits a breakpoint that returns SC/MP to the MONITOR where it waits for further instructions.

MACHINE CODE (HEX)		ASSEMBLY LANGUAGE			
MEMORY LOCATION	OP CODE	LABEL	MNEMONIC OP CODE	OPERAND	COMMENT
0F00	C4	INIT	LDI	IMMEDIATE	
0F01	01			01	AIM PTR-3
0F02	37		XPAH		AT
0F03	C4		LDI	IMMEDIATE	"GECO"
0F04	85				ROUTINE
0F05	33		XPAL		IN KITBUG
0F06	08		NOP		
0F07	08		NOP		
0F08	C4		LDI	IMMEDIATE	
0F09	0F				AIM PTR-2
0F0A	36		XPAH		AT FREE
0F0B	C4		LDI	IMMEDIATE	AREA
0F0C	B0				IN RAM
0F0D	32		XPAL		
0F0E	08		NOP		
0F0F	08		NOP		
0F10	C4		LDI		
0F11	0F				AIM PTR-1
0F12	35		XPAH		TO START
0F13	C4		LDI		OF BUFFER
0F14	30				AREA IN RAM
0F15	31		XPAL		
0F16	08		NOP		
0F17	08	LOOP	NOP		
*0F18	CD		ST	PTR-1	STORE INPUT
0F19	01			Δ = 1	
*0F1A	3F		XPPC	PTR-3	BORROW "GECO"
0F1B	08		NOP		
0F1C	90		JMP		
0F1D	FA			Δ = −6	
0F1E					
0F1F					

*THESE INSTRUCTIONS SHOULD PROBABLY BE REVERSED IN SEQUENCE, THOUGH THE PROGRAM OPERATES AS IS.

Fig. 3—Borrowing routines from the μP-supplier's firmware is one way to get software results fast. Here we have a program in which the author borrows the SC/MP KITBUG MONITOR's "GECO" routine to enter characters into the SC/MP RAM from the TTY keyboard. The author's part of the program is short and simple as shown because the borrowed "GECO" does all the work. In the future, this practice of borrowing "canned" routines will become as prevalent in the software-design field as the use of potted circuit modules is in the hardware-design field.

(In the interests of simplicity, we've omitted several details that a person wanting to use this system would also have to know. For instance, he should be aware of how to set up the length of the number or digits per number and enter that value; otherwise the μP won't know when it has finished dialing all digits. Moreover, if the user wants to store several numbers and then select a given number, he should know how to enter the program and change the starting vector. We leave these details as an exercise for the reader.)

Too much space is better than not enough

EDN's approach to the creation of a new program first blocks out or maps the memory. We arbitrarily assign various specific locations in memory for each of the parts of the software that we think we'll be writing. (This method gives us the illusion, at least, that we are organized!)

Our coding worksheets have 32 lines which match up with 32 bytes of RAM. (We don't restrict our instructions to a single line; if they are 2-byte instructions, they take two lines.) We tend, therefore, to map our memory space into 32-byte blocks. Fortunately, these blocks more often than not are adequate for our routine elements.

When we began working on this application, we observed that it obviously needed a buffer area to hold the numbers to be dialed, so we arbitrarily placed that at location 0FA0. This left us some room to add additional numbers or some identifying alphanumerics before we ran into the forbidden area of SC/MP's RAM (location 0FEC onward is used by the MONITOR).

We left space open at the very beginning of RAM for some of the temporary storage places we would need for pulse and digit counters. It's easy to remember the addresses when they're right at the beginning of RAM. The start of the program we put at 0F10, assuming that the 32-line work sheet starting here would be devoted to initializing the SC/MP pointers. Next, we assigned the "main line" of the program to 0F30 and the pulsing subroutine following that at 0F50. Although these assignments were just guesses, they worked out well and left plenty of room to spare—as you can see by the liberal sprinkling of NOP's throughout. Of course, when you are hand-assembling an initial "breadboard" program, it is far better to have much wasted space like this than to stop in the middle of your effort and relocate routines to make space for code that has grown too tight for the space originally mapped.

Writing the pulsing subroutine

We tackled the dial-pulse-generating subroutine first because if we couldn't get this working, there would be no use in going further. With SC/MP, however, this function turned out to be duck soup, as you can see in **Fig. 4.** The 10-Hz relay-break signal pulse was programmed within an acceptably close tolerance by SET FLAG 1 and RESET FLAG 1 operations spaced apart by 0.05-sec delays. The DLY instruction is set up with the accumulator and second-byte values to produce these delays.

The SET FLAG 1 we accomplished by loading 02 (hex) into the accumulator and copying that bit pattern into the status register. The 02 places a binary ONE in FLAG 1's bit position, setting FLAG 1. Because SC/MP constantly provides a readout of its status-register flags on output pins, we could use the FLAG 1 condition to directly drive the relay. After another 0.05-sec delay, we loaded a 00 value into the accumulator and copied it into the status register to clear FLAG 1. The entire pulsing routine is as simple as that.

Although this program works, we plan to make two changes in it when time permits. First, we want to change the break-make ratio from its present 50-50 value to 60-40 to better match phone-company requirements. Second, we want to use ORI (OR immediate) and ANI (AND immediate) instructions in setting and resetting FLAG 1 to avoid changing any of the other status bits in the process. If we do this, though, we will first have to load the existing status value into the accumulator before performing the ORI and ANI.

The housekeeping at the end of this subroutine uses SC/MP's DLD (decrement and load) instruction to keep count of the number of pulses remaining to be output by subsequent traverses of the loop. Each pass produces a pulse and, also because of the DLD instruction, decrements the digit being processed in its temporary storage location, 0F00. When this digit decreases to zero, the JNZ decision instruction exits the SC/MP from the loop and on to the end of the subroutine.

At the end of the subroutine, a XPPC (PTR-2) causes the switch between the PC and PTR-2 that effects the return to the main line. The JMP following this is necessary because we wish to re-enter this program repeatedly during the course of dialing a number. This is an important trick because SC/MP has no jump-to-subroutine instructions, per se. The JMP is placed here to catch the PC at the point that a re-use of PTR-2 will place it. (Stop and think: What value will the final XPPC instruction switch leave in PTR-2? It will be that of the PC when it got to the final XPPC.) This JMP catches the PC and moves it up to the

A bitter pill to take?

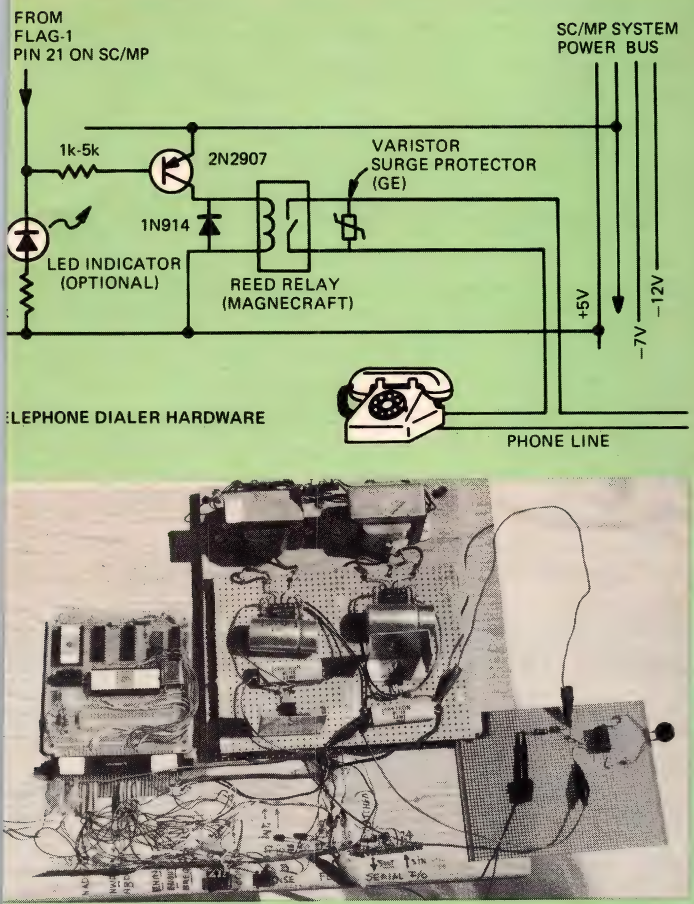
EDN would like to take many of the µP manufacturers to task. We feel that they often work too hard to sugar-coat the programming process by providing aids such as automatic assemblers that effectively insulate the user from many hardware puzzles. Such aids may be fine for large minicomputer users or hobbyists who only want to run BASIC, but they are wrong for the OEM designer.

The OEM designer must get right in and learn first-hand all the little tricks of the machine that he'll need to know intimately to make his design economical and foolproof on the market.

This holds particularly true in the case of SC/MP. Frankly, we are somewhat perplexed that National would ship the $99 kit with so little advice on hand coding and hand assembly. While this is really the only significant fault that we've found with the kit package, it is unfortunately an important one.

Why do we say this? Because SC/MP's architecture is somewhat unusual. On one hand it uses pointer registers like the 8080, while on the other, it offers multiple addressing modes like the more classical 6502. Yet SC/MP's pointer registers aren't as good as those in the 8080, nor does it have the extensive multiple-mode addressing of the 6502. Moreover, it's a relatively slow machine. Thus SC/MP looks bad in direct comparison to either machine.

However, on its own, the SC/MP architecture permits some pretty unique swaps among all its CPU registers. _If_ a programmer knows the machine well enough to take advantage of these swaps, he can do such things as turn any (or all) of the three pointer registers into stack or subroutine pointers. In the latter case, switching these pointers with the program counter can effect rapid entries and exits from subroutines. And if the programmer wants to go really wild, he can swap the accumulator with either half of the PC—a useful trick for some problems.



	MACHINE CODE (HEX)		ASSEMBLY LANGUAGE			
	MEMORY LOCATION	OP CODE	LABEL	MENMONIC OP CODE	OPERAND	COMMENT
	0F00	04		DIGIT		TEMPORARY "SCRATCH
	0F01	0A		COUNT		PAD"LOCATIONS
ENTRY FROM MONITOR	0F10	C4	INIT	LDI	IMMEDIATE	
	0F11	0F			0F	SET UP PTR-1
	0F12	35		XPAH		TO FIRST DIGIT
	0F13	C4		LDI	IMMEDIATE	OF TEL. NO.
	0F14	A0			A0	TO BE DIALED
	0F15	31		XPAL		
	0F16	C4		LDI	IMMEDIATE	PUT NUMBER OF
	0F17	0A			LENGTH	DIGITS IN TEL. NO.
	0F18	C8		ST		INTO
	0F19	E8			Δ	LOC. 0F01
	0F1A	C4		LDI	IMMEDIATE	
	0F1B	0F			0F	SET UP
	0F1C	36		XPAH		PTR-2
	0F1D	C4		LDI		FOR PULSING
	0F1E	50			50	SUBROUTINE
	0F1F	32		XPAL		AT 0F50
	0F20	08		NOP		
	0F30	C5	MAIN	LD	(PTR-1)	GET NEXT
	0F31	01			Δ = 1	DIGIT OF
	0F32	C8		ST	PC REL	TEL. NO.
	0F33	CD			-51_{10}	FROM BUFFER
	0F34	3E		XPPC	(PTR-2)	JUMP TO PULSING SUB.
	0F35	08		NOP		
	0F36	08	TO	NOP		
	0F37	08	SUB	NOP		
	0F38	C4		LDI	IMMEDIATE	
	0F39	FF			FF	MAX.
	0F3A	8F		DLY		DELAY
	0F3B	FF			FF	
	0F3C	B8		DLD	PC REL	
	0F3D	C4			-60_{10}	HOUSEKEEP
	0F3E	98		JZ	PC REL	LOOP
	0F3F	08		END		
	0F40	08		NOP		
	0F41	08		NOP		
	0F42	08		NOP		
	0F43	90		JMP	PC REL	DO
	0F44	EB			-21_{10}	AGAIN′
	0F45	08		NOP		
	0F46	08		NOP		
	0F47	08		NOP		
RETURN TO MONITOR	0F48	3F	END	XPPC	PTR-3	BREAKPOINT
	0F49	08		NOP		
	0F4A	08		NOP		
	0F4B	08		NOP		
	0F4C	90				
	0F4D	FE				LOOP TO TRAP
	0F4E	08		NOP		PROGRAM, "IN CASE"
	0F4F	08		NOP		
PULSING SUB-ROUTINE	0F50	08	SUBR	NOP		
	0F51	08		NOP		SPACE FOR
	0F52	08		NOP		CHANGES
	0F53	08		NOP		
	0F54	C4		LDI	IMMEDIATE	
	0F55	00			00	DELAY #1
	0F56	8F		DLY		~0.05 SEC.
	0F57	30			0A	
	0F58	C4		LDI	IMMEDIATE	
	0F59	02				SET FLAG 1
	0F5A	07		CAS		
	0F5B	C4		LDI	IMMEDIATE	
	0F5C	00			00	DELAY #2
	0F5D	8F		DLY		~0.05 SEC.
	0F5E	03			09	
	0F5F	08		NOP		
	0F60	C4		LDI	IMMEDIATE	
	0F61	00				RESET FLAG 1
	0F62	07		CAS		
	0F63	08		NOP		
	0F64	B8		DLD		LOOP
	0F65	9B				HOUSEKEEP:
	0F66	9C		JNZ		MORE
	0F67	EC				DIGITS?
	0F68	08		NOP		
	0F69	3E		XPPC	(PTR-2)	RETURN FROM SUBR
	0F6A	90		JMP	PC REL	FOR RE-ENTRY
	0F6B	E8			−10	
	0F6C	08				
DATA BUFF	0FA0	04	BUFF	4		AREA
	*0FA1	0A		0		CODE
	0FA2	08		8		
	0FA3	07		7		
	0FA4	03		3		NUMBER TO
	0FA5	07		7		BE DIALED
	0FA6	05		5		
	0FA7	01		1		
	0FA8	02		2		
	0FA9	01		1		
	0FAA					
	0FAB					

*0 MUST BE CONVERTED TO A (HEX) TO PRODUCE REQUIRED 10 PULSES.

Fig. 4—Both hardware and software allowing the computer to automatically dial telephone numbers was well within the SC/MP kit's capability. The hardware **(a)** uses one of the CPU output pins directly (FLAG 1 on pin 21) to drive a small DIP-packaged reed relay with the help of a pnp transistor. The reed relay provides the means for interrupting the telephone line, and as the system holds these contacts normally closed, the regular rotary dial can still be used. The software **(b)** consists of four elements mapped in the SC/MP's RAM memory as shown, and described in detail in the text. Sufficient room remains in the small 256-byte RAM for additional functions and numbers to be dialed.

start of the subroutine, just where we want it to begin.

Setting up the pointers

Having gained confidence that the pulsing subroutine would do the job, we set that aside and turned our attention to the main program; specifically, the initialization at 0F10. By now we had a pretty good idea what needed to be initialized. An obvious strategy in using a μP like the SC/MP is to utilize the CPU pointer registers for the most important addressing functions; while using other means, such as immediate addressing or PC-relative addressing, for all other tasks. With this approach, you won't have to disturb the contents of the pointers you've set up during the course of program execution. A good reason for trying to keep your SC/MP program compact is that then you can reach across it with the machine's PC-relative mode of addressing, which has a span of only −128 to +127.

For this application, we determined that the most important addressing function was pulling the digits of the number to be dialed one-by-one out of RAM and placing them in location 0F00 for use by the pulsing subroutine. We decided to use PTR-1 for this task, so accordingly we had the initialization routine load PTR-1 to point at 0FA0, the first digit of the number in the buffer.

With the SC/MP μP, initialization of the pointers must be accomplished in several steps, unless you want them at the zero value to which they are set by RESET. (SC/MP is one of the few μP's besides the Intel MCS-4 where the RESET input completely zeroes all CPU registers, not just the PC.) To initialize the first pointer, you must first load the value for one of the bytes into the accumulator, then switch it into place in the pointer register by XPAH or XPAL instruction. You complete the operation by similarly loading the value for the other byte into the accumulator and switching it into place.

With pointer-1 set up, the initialization routine must also ensure that the number of digits of the number to be dialed is placed in location 0F01, since the main-line routine needs this information to know when it has processed the entire number. For example, if a 7-digit number plus a 3-digit area code is to be dialed, the value 10 or hex A must be loaded into location 0F01. Because this line-data movement did not seem to warrant the use of one of SC/MP's pointer registers, we stored it into location 0F01 with PC-relative addressing after loading it into the accumulator with the usual immediate instruction.

The final task of the initialization process points one of the SC/MP pointers at the pulsing subrou-

How to select a μP

The μP-selection worksheet shown illustrates how we think a designer should approach the μP-selection task. Following the first column that lists available μP's, there are two checklist columns. In the first of these, A, the designer evaluates his own qualifications for judging each μP. "How well do I know the μP?" the designer asks, and he scores himself with an arrow that indicates on a scale of 0 to 100 percent how far he believes he has brought himself up to speed on the particular μP.

The arrows in column A are the author's evaluation of his knowledge of the various μP's listed. The 3-mo. familiarization level is equated with 60% on the column-A rating scale.

Column B serves for rating each μP with respect to its suitability for the application under consideration; in this case, the telephone-dialing system. Practically everyone with experience in applying μP's now agrees that a fresh evaluation must be made for each new application. The ratings represent best guesses. The self-ratings alongside column A serves to remind all concerned that some of these ratings were made with admittedly insufficient background.

Comments column, C, provides a starting point for the more general discussions that should take place during the selection process. Likely top contenders can be singled out; obvious misfits can be tentatively eliminated. Everything in-between may be tagged with its good and bad points.

In our evaluation for the telephone-dialing system, the little 4-bit machines (4004 and PPS-4) were set aside as having interest only if the dialing system was to handle BCD numbers exclusively. Since the system must also handle alphanumeric characters as well, it was felt that a wider word width would prove desirable.

The one-chip machines (such as the TMS 1000) were ruled out for the prototype system because they really only make economic sense when their programs are masked onto the single chip, and no need for extensive RAM exists. But we noted that they could become of interest in the future if high-volume markets developed for the dialer.

The 8-bit machines appeared best for the initial product, and among these machines the SC/MP, F8 and 650X were singled-out as the top choices. These choices were obviously biased by the author's familiarity with these μP's, as a scan down column A indicates. The 8080 was considered a strong runner-up, because of its many second sources. (In many real-life situations, the 8080 wins out since top management vetoes the designer's preferred choices because they lack the second sourcing of the 8080.) The 6800 was ruled out because it is very similar to the 650X but requires more auxiliary components.

The Z-80 would at first appear as overkill for a simple telephone-dialing application. Yet, the Z-80 has some bit-handling abilities that might allow it to handle serial I/O quite efficiently. Its block-search superinstructions would be most efficient for looking up telephone numbers on the basis of party names. The Z-80's final rating for this application would depend on how fast and how far its tine (location 0F50). It must be ready for when the XPPC instruction calls the subroutine. Ordinarily we would have followed National's programming convention for SC/MP and used PTR-3 for this. However, in this case we knew that KITBIG uses PTR-3 for its return, so we did not want to disturb that if possible. Therefore, since we weren't using PTR-2 to implement a stack in this application—at least at this stage of program development—we assigned PTR-2 the function of holding the subroutine's address. Accordingly, we loaded it up with 0F50, the subroutine's starting address.

A string of NOP's (no operation) all the way to the beginning of the next "main-line" routine at location 0F30 finishes off the initialization routine. While NOP's may not be as elegant as putting in a single PC-relative JMP to the next routine, a string of them takes very little time to enter because all you need do is alternately hit the "8" key and the "CR" key on the TTY. Further, NOP's make it easy to patch in any instructions you might have forgotten, or to add any breakpoints or FLAG signals that occur to you later.

Main-line routine marches the digits in

The "main-line" routine moves the digits to be dialed in from the buffer one-by-one and calls the pulsing subroutine to process them. Having already set up PTR-1 to point at the first digit of the number to be dialed in the buffer during the initialization, we now can issue a LD (load) command using PTR-1 as the pointer. Using SC/MP's auto-indexing mode here seemed appropriate because we want the PTR-1 to point at the following digit the next time we use this instruction. The LD will thus bring the digit into the accumulator and then we can use a PC-relative ST (store) to send it to location 0F00

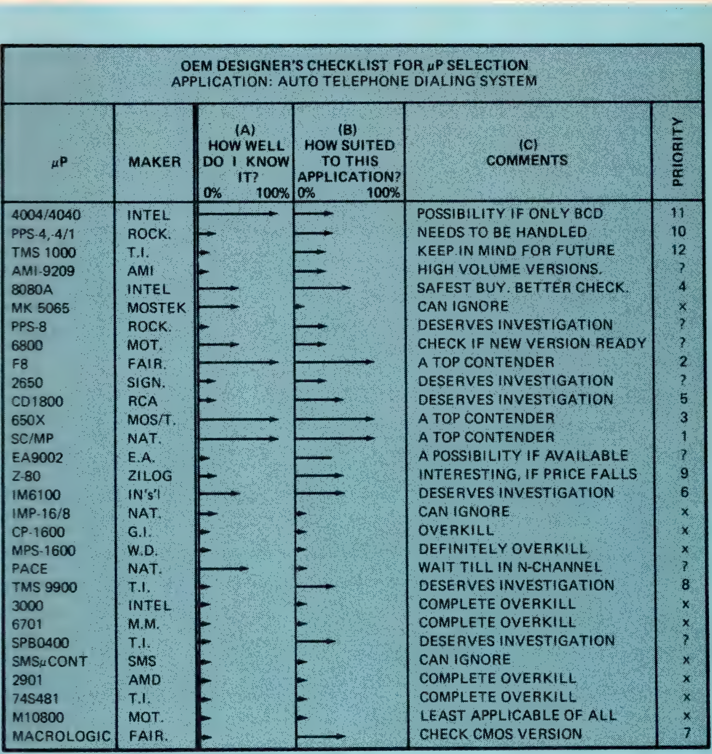
price comes down in the immediate future.

The three CMOS machines—the RCA 1800, Intersil IM1600 and the CMOS version of the Fairchild Macrologic—were put aside in a special group. They might just be what is needed if early market trials show part of the market demands battery-operated systems that could keep going despite power-line failures (the police and fire-department markets, for example). Possibly, small systems using these machines could operate directly off telephone-line power, or be carried about by salesmen in their brief cases.

With three exceptions, all the 16-bit MOS machines and all the bipolar-slice machines were ruled out as overkill for this application. The exceptions were the I²L SBP0400 and TMS 9900 from Texas Instruments and the PACE from National Semiconductor.

The I²L machine was the "darkest horse," because the author had least direct familiarity with it or any machine like it. However, several of its claimed features were of interest: the ability to operate from very low voltage supplies (0.85V); the way it could be throttled back to very low power-consumption levels; and the technical feasibility of incorporating husky bipolar drive transistors on the same chip.

The TMS 9900 has two provocative features: built-in serial I/O ports like the SC/MP and a multiprocessing architecture. The latter feature might prove ideal for implementing a centralized dialing system that would serve all the phones in an office. Just think! Such a system could have a whole directory on disc for real-time instant use by everyone.



OEM DESIGNER'S CHECKLIST FOR µP SELECTION
APPLICATION: AUTO TELEPHONE DIALING SYSTEM

µP	MAKER	(A) HOW WELL DO I KNOW IT? 0% 100%	(B) HOW SUITED TO THIS APPLICATION? 0% 100%	(C) COMMENTS	PRIORITY
4004/4040	INTEL			POSSIBILITY IF ONLY BCD	11
PPS-4,-4/1	ROCK.			NEEDS TO BE HANDLED	10
TMS 1000	T.I.			KEEP IN MIND FOR FUTURE	12
AMI-9209	AMI			HIGH VOLUME VERSIONS.	?
8080A	INTEL			SAFEST BUY. BETTER CHECK.	4
MK 5065	MOSTEK			CAN IGNORE	x
PPS-8	ROCK.			DESERVES INVESTIGATION	?
6800	MOT.			CHECK IF NEW VERSION READY	?
F8	FAIR.			A TOP CONTENDER	2
2650	SIGN.			DESERVES INVESTIGATION	?
CD1800	RCA			DESERVES INVESTIGATION	5
650X	MOS/T.			A TOP CONTENDER	3
SC/MP	NAT.			A TOP CONTENDER	1
EA9002	E.A.			A POSSIBILITY IF AVAILABLE	?
Z-80	ZILOG			INTERESTING, IF PRICE FALLS	9
IM6100	IN's'l			DESERVES INVESTIGATION	6
IMP-16/8	NAT.			CAN IGNORE	x
CP-1600	G.I.			OVERKILL	x
MPS-1600	W.D.			DEFINITELY OVERKILL	x
PACE	NAT.			WAIT TILL IN N-CHANNEL	?
TMS 9900	T.I.			DESERVES INVESTIGATION	8
3000	INTEL			COMPLETE OVERKILL	x
6701	M.M.			COMPLETE OVERKILL	x
SPB0400	T.I.			DESERVES INVESTIGATION	?
SMSµCONT	SMS			CAN IGNORE	x
2901	AMD			COMPLETE OVERKILL	x
74S481	T.I.			COMPLETE OVERKILL	x
M10800	MOT.			LEAST APPLICABLE OF ALL	x
MACROLOGIC	FAIR.			CHECK CMOS VERSION	7

The PACE is SC/MP's "big brother," having all of SC/MP's features plus others. Two PACE features possibly pertinent to the telephone-dialing application are PACE's ability to pack and manipulate four BCD numbers in its 16-bit word, and its fully implemented 5-level interrupt system. However, while National is currently readying the n-channel version of SC/MP, the n-channel version of PACE is not scheduled until some time next year. The present PMOS PACE does not really suit low-cost systems; it needs too many power supplies and outboard drivers for the busses.

where the pulsing subroutine expects to find it.

But in setting up the auto-indexing LD to get the digit into the accumulator, we made one of those stupid mistakes common to computer programmers: We left the second byte of the LD instruction (at location 0F31) zero, assuming that this was for a displacement as in some of the other modes of SC/MP addressing that we'd used. When checking out the program, we could not understand why no auto-indexing (or auto-incrementing, to be more precise) wasn't taking place.

Upon re-checking the SC/MP instruction manual, we discovered that this second byte determines the amount by which the pointer auto-indexes. Thus, National provides a surprisingly powerful SC/MP instruction here. It allows you to auto-index the designated pointer forward or backward by amounts ranging all the way from −128 to +127. Knowing this, we put the 01 value in the second byte of the LD at location 0F31 and got the auto-incrementing we wanted.

As soon as this "main-line" routine gets the digit from the buffer and places it in location 0F00, it calls the pulsing subroutine with the XPPC (PTR-2) instruction. In turn, this causes PTR-2 to be swapped with the PC and sends SC/MP to the pulsing subroutine. This, then, serves as an example of how SC/MP achieves subroutining despite its having no jump-to-subroutine instructions.

When SC/MP returns from the excursion to the pulsing subroutine, it must perform a maximum delay for the main-line program. The largest possible values—FF—are in the accumulator and in the second byte of the DLY, giving a pause of about 0.26 sec. We use this to simulate the pause between dial rotations, and have made no attempt to optimize the delay length.

The final instructions in the "main-line" program do the housekeeping that tells SC/MP whether all the digits have been processed. The same DLD (decrement and load) instruction used in the pulsing subroutine performs this task. However, in the "main-line" program the count is maintained in location 0F01, not 0F00. (Recall that location 0F01 is set up during the initialization to indicate how many digits are in the number to be dialed.)

Another main-line difference, compared to the pulsing-subroutine loop's housekeeping, is that we use the opposite-logic decision, JZ (jump-if-zero), rather than the JNZ (jump-if-not zero). This JZ permits the SC/MP to keep going down to the JMP at line 0F43 for another loop repeat until the digit count in 0F01 decrements to zero. JZ then sends the program past the JMP to the breakpoint instruction, XPPC (PTR-3) at location 0F48. In turn that sends SC/MP back to the MONITOR, signifying that the number has been dialed.

How does the SC/MP compare to other μP's?

EDN strongly advises against forming any conclusions about the relative merits of a particular μP vs. other machines until you have fully familiarized yourself with the operation of each model in question. In many cases, our hands-on experimentation with a μP revealed it to have significant advantages in certain situations. That is, no one μP seems to fit all applications: Every μP has its faults and virtues.

For us, a μP like the 6502 has a strong appeal because it fits so closely to our long-term concept of what a classic SP/GP/DC (stored-program, general-purpose, digital-computer) should look like. Yet, machines like the F8 and SC/MP prove better suited for certain specialized end applications. The F8's strength is the way it sports four 8-bit, bus-oriented, I/O ports in just a 2-chip system. The F8 also augments this strength with sophisticated built-in interrupt-driving timers, daisy-chainable external interrupts and tightly coupled DMA expansion.

The SC/MP also excels in I/O, but I/O of a quite different nature. SC/MP's I/O consists of slow serial paths, more suited to slow or moderate-speed industrial control. When it comes to CPU-hardware controllability, SC/MP definitely outperforms the F8 and most other μP's. Our experience with the SC/MP breadboard revealed the ease of connecting switches and indicating LED's to SC/MP CPU pins to manually control the chip and discover what it is doing.

Further, we feel that SC/MP would be an exceptionally easy machine to add to an existing system of TTL parts and electromechanical elements. True, some of the other μP's might result in a superior system, but only if the total system were re-designed from scratch to take advantage of them. Finally, the SC/MP seems to have more "handles" for the designer to get at than any other μP.□

Article evaluation: Please circle one on R.S. card.

Read Some—No. 307 Read Most—No. 308

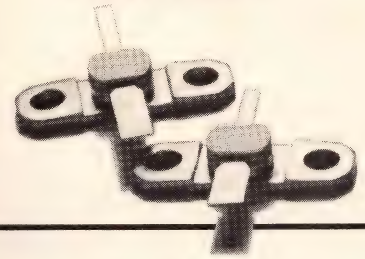
References

1. *"SC/MP Technical Manual," National Semiconductor Corp. Publication No. 4200079A.*
2. *"SC/MP Kit User's Manual," National Semiconductor Corp. Publication No. 4200113A.*
3. *"SC/MP Programming and Assembler Manual," National Semiconductor Corp. Publication No. 4200094B.*
4. *"SC/MP Applications," (a forthcoming publication from National Semiconductor Corp. that will have numerous "turnkey" applications for SC/MP).*
5. *Frank, Roger B., "Is there a Home for Scamp?," Interface, July, 1976, pg. 76 (a short article that points out SC/MP's virtues as an I/O processor).*

Blowoutproof

TRW Microwave Transistors

2 GHz		3GHz
TRW 2001	1w	TRW 3001
TRW 2003	3w	TRW 3003
TRW 2005	5w	TRW 3005
TRW 2010	10w	
TRW 2015	15w	
TRW 2020	20w	



TRW gold-metallized 2 and 3 GHz parts can withstand any mismatch load condition up to and including open and short circuit.

To the *design engineer* infinite VSWR means far more latitude in experimentation and manufacture. To the *production manager* infinite VSWR means zero production boo-boos. To the *purchasing department* TRW parts mean drop-in replacement with off-the-shelf availability and very competitive prices.

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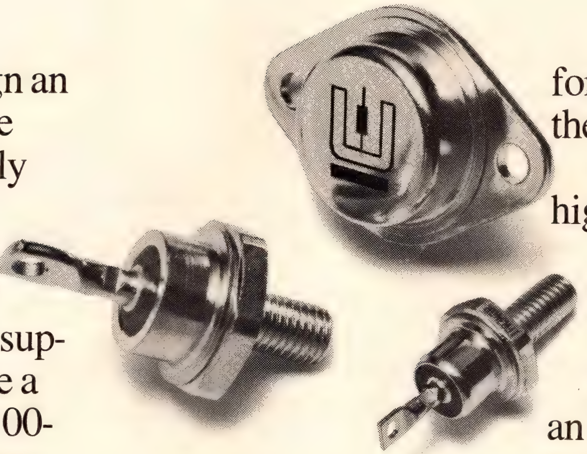

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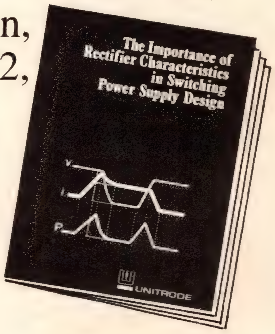

The Importance of Rectifier Characteristics in Switching Power Supply Design

UNITRODE

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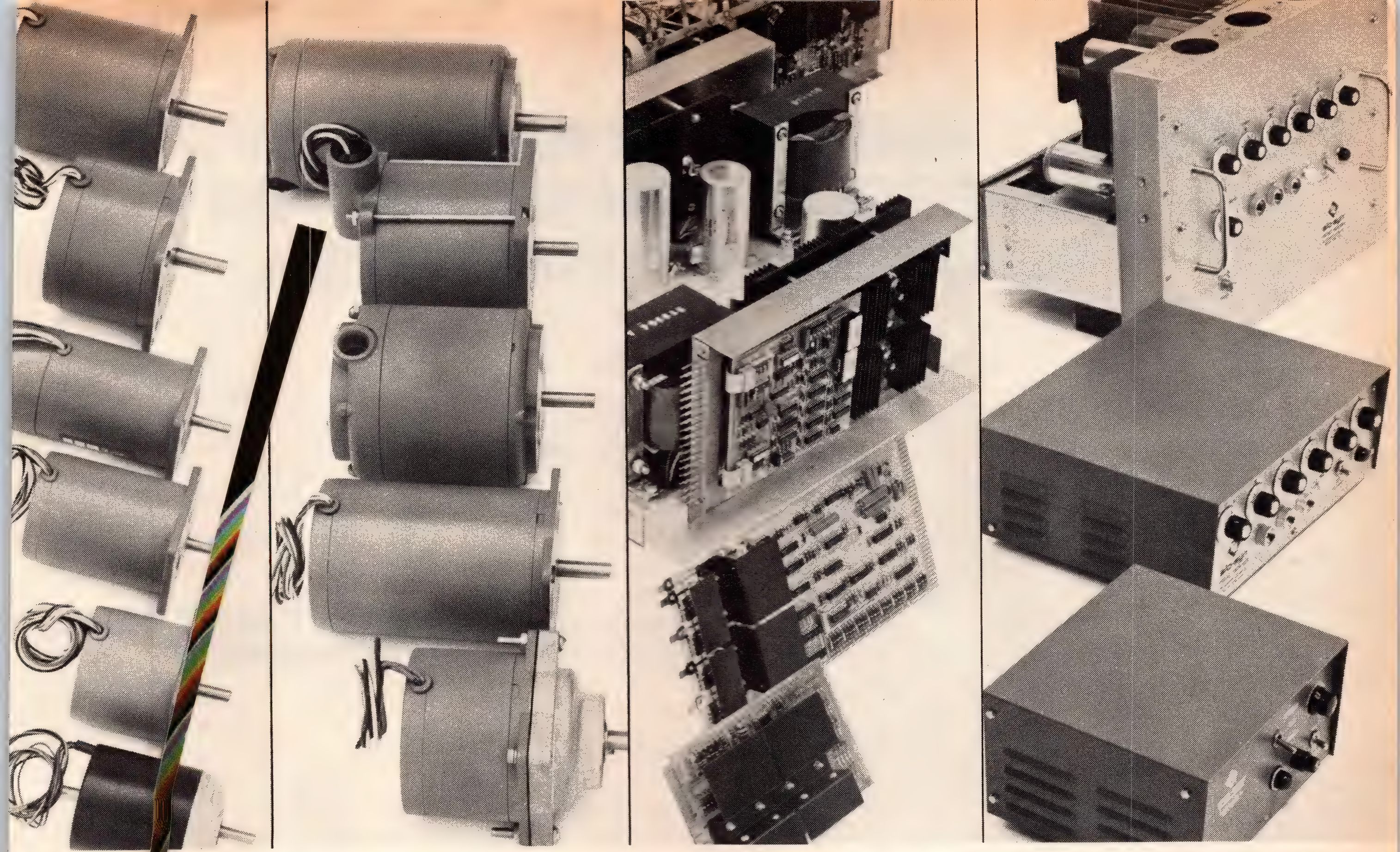
For more information, Circle No. 52



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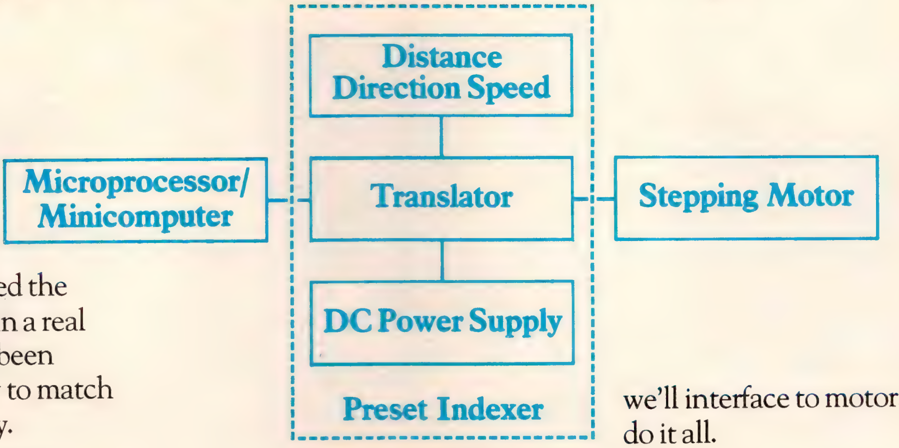

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Is there a "best" approach when implementing a computer system?

Computer systems must frequently meet an end user's particular needs. But system and/or component selection is not a simple process.

John Mucci, Digital Equipment Corp.

Putting a computer system together implies no single, all-encompassing approach to the problem. If one existed, natural selection would eliminate all alternative methods. Still, persons or organizations have essentially three viable choices: They can design the system from the ground up; purchase a turn-key configuration from a manufacturer or systems-house; or modify an existing design. Each solution has both strengths and weaknesses and favors a different type of potential user.

Take a slab of silicon, draft some masks...

Design "from the ground up" **(Fig. 1)** is, in one sense, the least expensive way to configure a system. Primary costs include only the physical hardware and a minimum amount of software (the lowest cost cases involve only assembly and edit-routine expenses). Since the user develops all the interfacing, application software, and support functions, such a system most closely integrates with the final application. Furthermore, a user primarily involved in instrumentation design generally has a deep understanding of the process to be computerized: He intuitively realizes the full implications of any specifications quoted, as well as pitfalls to watch out for.

Thus with his intimate knowledge of the application, the user can develop a system with expansion capabilities and know how to add them to existing designs. In computer systems developed in assembly or machine language, this reduces internal-memory requirements to an absolute minimum.

Fig. 1—"Built-from-scratch" systems, designed around a basic minicomputer, cost least in terms of immediate hardware investments and find great use in unique application situations. Unfortunately, development of software and interfacing often raises the real costs of such a system.

But problems do exist!

Although this "basic" type of design features many advantages, drawbacks do exist. For example, the designer must assume full system responsibility; i.e., all documentation, training, and maintenance. No manufacturer can (or can afford to) guarantee the operation of a computer system as a system if built by another party—unless, of course, the user contracts with a manufacturer to assume that responsibility. But this approach could cost orders-of-magnitude more than a custom-designed system!

Developing and maintaining a system can also take substantial time. The designer must be conversant with both the hardware of the application and of the computer. Then he must determine which computer-equipment components—storage devices, interfaces, visual displays—to choose. If the same company does not manufacture the peripherals as well as the central processing unit, the designer must even check for correct connections. He thus, in effect, becomes the manufacturer of the system.

And there's a soft spot here, too!

System software also becomes a responsibility of the designer, and this requires expert programming. Development time for software delays use of the system and costs money—particularly if working in low-level languages becomes necessary. Full software development can range from many man-months to over a man-year of effort!

Though users can rent time on an equivalent computer to develop software while awaiting delivery of the hardware, this approach costs additional money and assumes that the design is fairly firm from a hardware standpoint.

"From-the-ground-up" software development thus proves most practical in situations of extremely limited equipment budgets; in variable-workload cases with "famine" periods normal to the job; or when programming labor is obtainable at very low cost. These conditions often occur at colleges and universities.

Much can be said for this method of system design, particularly where the economics of the situation permit. But the designer must thoroughly document hardware and software features of the system. In more than one case a system is configured, programmed, debugged, and modified by a single individual who keeps "mental files." Should that person leave for some reason, any system malfunction turns into a full-fledged disaster.

On your left, the turn-key farm

A turn-key system (TKS) **(Fig. 2)** represents the "complete" solution for many users. Merely turning the computer ON and doing the equivalent of hitting a "start" button activates the system. These systems come as standard packages from manufacturers or system houses. Frequently preferred by not especially computer-oriented types, a complete turn-key configuration requires little programming knowledge on the user's part. However, the manufacturer must take full responsibility for its operation, including training of operators, documentation, hardware-software integration, and system maintenance. Thus, the owner of a turn-key system need only note whether the system is running; in the case of a malfunction, a specialist is called.

Fig. 2—Can you find the CPU in this picture? Probably not! Turn-key systems, such as the one shown here, keep the operator almost totally away from the "nuts-and-bolts" side of data processing.

This road also has potholes!

Unfortunately, letting the manufacturer "do the dirty work" makes a TKS the most expensive approach for customers in terms of initial costs. Other significant disadvantages exist for several classes of user. One major drawback depends on whether the system is "customized" or "off the shelf."

For many applications, a computer system should be able to evolve significantly to provide for growing needs. This is particularly true in areas involving computer control of instruments or processes.

Customized turn-key systems frequently lack this growth potential. Usually, the operator can specify only what he requires to solve the immediate problem. The specialty manufacturer develops the system to customer specifications and may thus be less able than the user to predict the direction of potential system growth. In fact, the user himself frequently cannot predict the way the system will grow. Such predictions aren't undesirable; rather, the computer system itself frequently affects the direction of growth. The system's features often suggest new applications or methodologies to the user once he becomes familiar with its capabilities and flexibility. But since adding new capabilities would increase system cost dramatically, a TKS designed "to specs" generally will do exactly what the user requested, and no more.

On the other hand, the "off-the-shelf" turn-key system usually has a little more flexibility than the custom-designed variety, though not much. Generally, this TKS is designed for a very specific function, and expansion may be limited to items like more terminals, increased memory capacity, or more bulk-storage peripherals.

Such "growth" frequently means just "more of the same"—useful to a certain extent, but hardly adding new system capabilities. This expansion should tend toward a direction the manufacturer deems best, even if at sharp variance with what the user desires. But expansion may make the job harder—as when a new monitor must go "on-line" to accommodate additional memory. Such restrictions can limit growth and evolution of systems extensively.

Fig. 3—Modified or modularly constructed systems, like this PDP-11 laboratory unit, make generalized approaches "fine-tunable" for specific applications. Since the manufacturers support both hardware and general software, this approach proves "optimum" for many users. Costs for a modular system fall between full turn-key and "from-scratch" approaches.

The "pipe wrench on the tilt valve" approach

A third approach to system design permits modification of an existing system **(Fig. 3)** to meet specific needs. Even this technique offers a range of options.

One, similar to the "from-scratch" technique, is to check with colleagues in related or similar disciplines to determine whether they have computer systems performing operations equivalent to those desired. A cancer researcher, for example, might wish to develop a computer system to automatically scan microphotographs of cell nuclei for abnormalities. If such a computer system does not already exist, the researcher could check such diverse fields as photomapping and high-energy nuclear physics. Both have computer systems with pattern scanning and recognition capabilities. Thus both from an engineering viewpoint and for programming time, to adapt such methods for cell scanning rather than start from the beginning is the best procedure.

This approach requires active cooperation by all parties; particularly those who developed the initial unmodified design. In some cases, the original developers invested many man-months or man-years of effort in their design and might not care to part with their work. If an agreement can be reached, the recipients should obtain sufficient information to avoid troubling the original designer for additional guidance—it's one thing to share design knowledge and quite another to be asked to troubleshoot somebody else's system!

Again, it's the designer's problem

As with a pure from-the-ground-up system, the entire support function of the system's operation "as a system" falls to the "designer" (in this case, the "adapter"). The adaptive designer can sidestep pitfalls that plagued the original designer if the unadapted computer was thoroughly debugged. The original designer may even supply the "adapter" with some troubleshooting hints. But as with the from-the-ground-up design, the system should be documented thoroughly so that necessary information in case of malfunction is immediately available to the adapter.

The other option is to purchase a "generalized" system adaptable to a specific application. Such systems more closely resemble turn-key systems than from-the-ground-up systems. Organized modularly, both in terms of hardware and software, a generalized type will frequently have some sort of executive (operating system) and some form of high-level language.

In the laboratory environment, for example, many problems in diverse fields are quite similar. Data from an instrument over a period of time must be collected, summed, and compared with other data already in the system's files. This could include data for nuclear magnetic-resonance (NMR) spectra in a chemical laboratory or evoked potential data in a life-sciences experiment. Either case uses a technique known as signal averaging. A computer system with a general signal-averaging program and provision for appropriate

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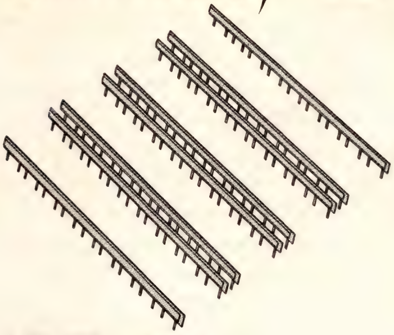
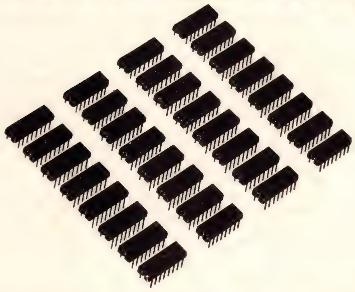
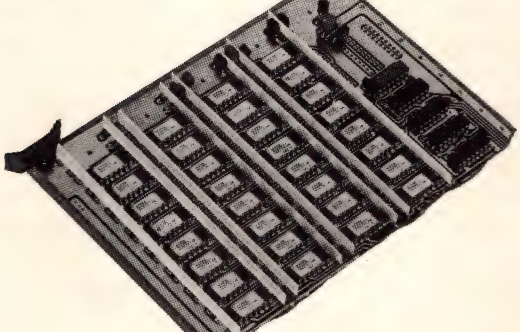


all these MOSTEK MK 4096 memory packages

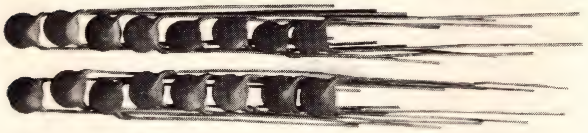


go on this 2-layer board



and work as they should!

. . . and these weren't needed!



Rogers Application Note No. 1976 tells the full story of how Mini/Bus makes PCB space-saving design easier, eliminates multi-layer PCBs, drastically reduces use of de-coupling capacitors. Write or call for a copy, so you'll know what others know!

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interfaces could be "customized" for either application rather easily. A number of "generalized" computer systems for laboratories are available.

A system with more good than bad?

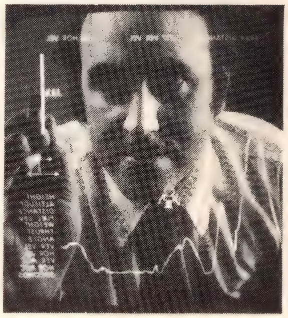
The adaptable computer system offers many advantages to the potential user. Chief among them is a basic system guaranteed to perform "as a system," including both hardware and a significant portion of the software. While the manufacturer won't support individual user-developed software elements, he will support his own software. Similarly, manufacturers can supply maintenance, training, and the like—except, again, for small special elements.

Because of its generalized nature, the system can also expand with little or no effort.

The "generalized" system, then, is a compromise between the totally individual system (the build-from-scratch variety) and the turn-key system. From a standpoint of initial investment costs, it falls somewhere in the middle—significantly more expensive than a "bare-bones" central processor, significantly less expensive than a full-blown turn-key system. For many users, this compromise proves the optimum solution.

Which of these three system approaches is right for you? Weigh all factors to determine the technique that best suits your budget and available resources. □

Author's biography



John Mucci, shown here playing "Lunar Lander" from a computer's eye view, is Maxi Systems' Marketing Manager for Digital Equipment Corp.'s Lab Data Products Div. in Marlboro, MA. John obtained his BA in physics from Penn. State Univ., his MS from Carnegie Institute of Technology and his PhD from Carnegie-Melon. He lists hunting, photography, bowling and table tennis as his leisure-hour pursuits.

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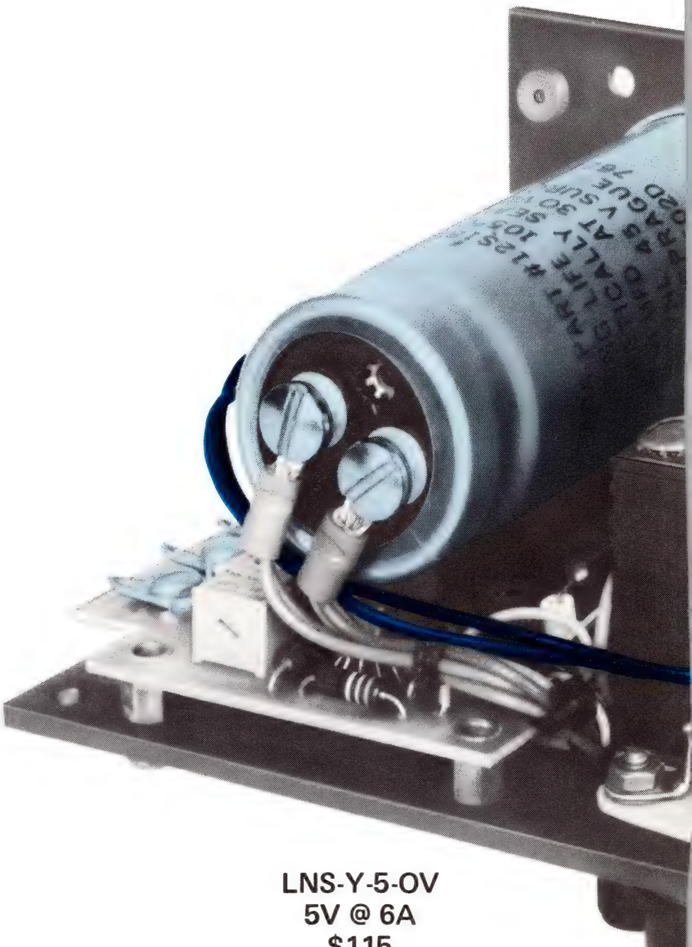

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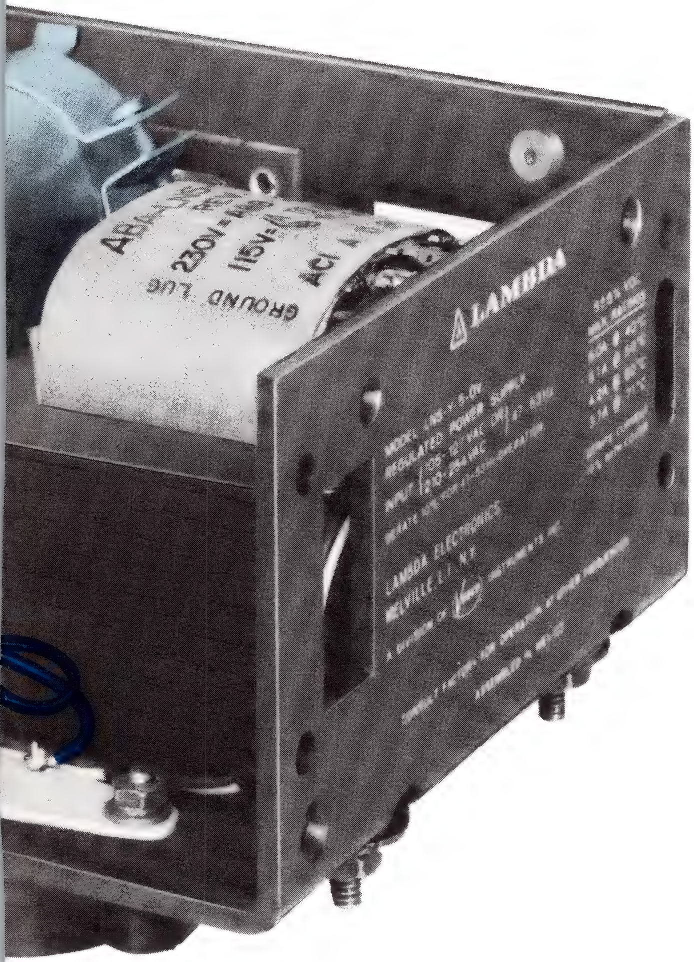

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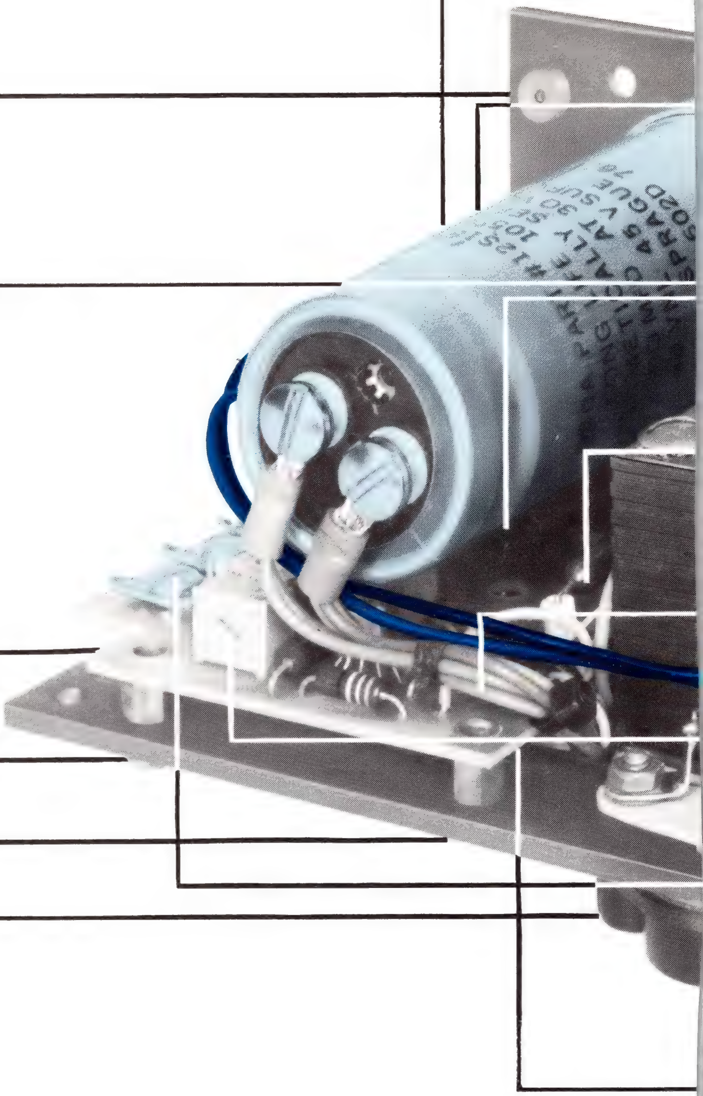

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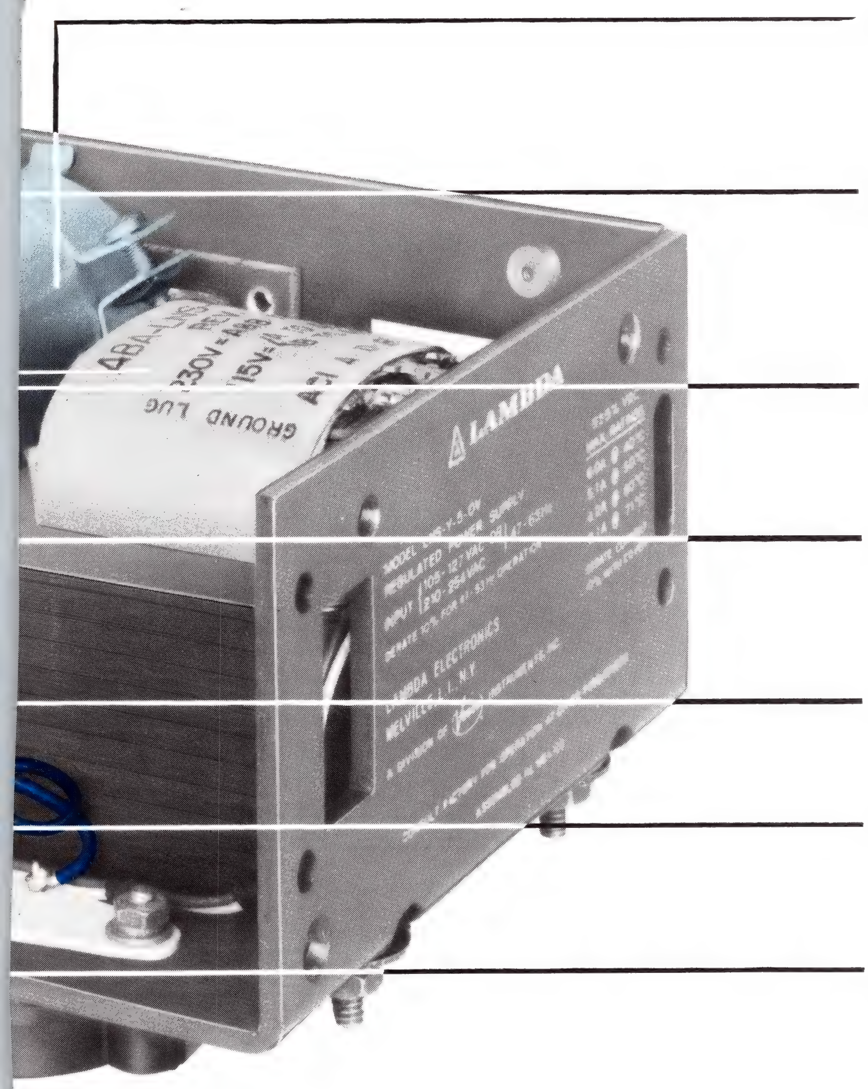

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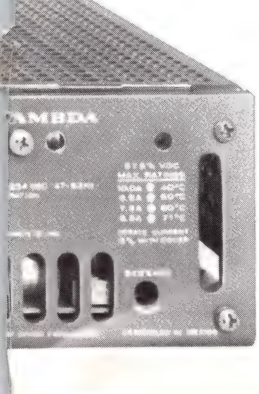

VOLTAGE AND CURRENT RATINGS

SINGLE OUTPUT

MODEL	REGULATION (LINE OR LOAD)	RIPPLE (RMS)	MAX CURRENT[1] AMPS AT 40°C	50°C	60°C	71°C	PKG SIZE	DIMENSIONS[2] (INCHES)	PRICE
5 VOLTS ± 5% ADJ									
LNS-Z-5-OV	0.15%	1.5	3.0	2.7	2.3	1.7	Z	4-7/8 x 4 x 1-3/4	**$ 80**
LNS-Y-5-OV	0.1%	1.5	6.0	5.1	4.2	3.1	Y	5-5/8 x 4-7/8 x 2-5/8	**115**
LNS-X-5-OV	0.1%	1.5	10.0	8.9	7.3	5.3	X	7 x 4-7/8 x 2-7/8	**140**
6 VOLTS ± 5% ADJ									
LNS-Z-6	0.15%	1.5	2.5	2.2	1.9	1.4	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-6	0.1%	1.5	5.6	4.9	4.0	2.9	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-6	0.1%	1.5	9.5	8.4	7.1	5.0	X	7 x 4-7/8 x 2-7/8	**130**
12 VOLTS ± 5% ADJ									
LNS-Z-12	0.15%	1.5	1.7	1.6	1.5	1.3	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-12	0.1%	1.5	4.0	3.5	2.9	2.2	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-12	0.1%	1.5	6.5	5.5	4.5	3.3	X	7 x 4-7/8 x 2-7/8	**130**
15 VOLTS ± 5% ADJ									
LNS-Z-15	0.15%	1.5	1.4	1.3	1.2	1.0	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-15	0.1%	1.5	3.4	3.1	2.6	2.0	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-15	0.1%	1.5	5.5	4.8	3.9	2.8	X	7 x 4-7/8 x 2-7/8	**130**
20 VOLTS ± 5% ADJ									
LNS-Z-20	0.15%	1.5	1.0	0.85	0.65	0.45	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-20	0.1%	1.5	2.7	2.5	2.0	1.3	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-20	0.1%	1.5	4.4	3.6	2.6	1.6	X	7 x 4-7/8 x 2-7/8	**130**
24 VOLTS ± 5% ADJ									
LNS-Z-24	0.15%	1.5	0.9	0.75	0.6	0.4	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-24	0.1%	1.5	2.3	2.1	1.7	1.1	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-24	0.1%	1.5	3.8	3.2	2.4	1.4	X	7 x 4-7/8 x 2-7/8	**130**
28 VOLTS ± 5% ADJ									
LNS-Z-28	0.15%	1.5	0.8	0.65	0.5	0.35	Z	4-7/8 x 4 x 1-3/4	**$ 75**
LNS-Y-28	0.1%	1.5	2.0	1.8	1.5	1.0	Y	5-5/8 x 4-7/8 x 2-5/8	**110**
LNS-X-28	0.1%	1.5	3.4	2.9	2.2	1.2	X	7 x 4-7/8 x 2-7/8	**130**

Note: 1: Derate current 10% when using cover for LN-Z and LN-Y models
Derate current 15% when using cover for LN-X models

2: Dimensions include cover

OVERVOLTAGE PROTECTORS

NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE[A] (VOLTS)	6 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000	12 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000
5	6.6 ± .2 (6.8 ± .2)[B]	L-6-OV-5	**$5**	**$4**	**$3.75**	**$3.40**	L-12-OV-5	**$10**	**$8**	**$7.50**	**$6.80**
6	7.3 ± .2	L-6-OV-6	**5**	**4**	**3.75**	**3.40**	L-12-OV-6	**10**	**8**	**7.50**	**6.80**
12	13.7 ± .4	L-6-OV-12	**5**	**4**	**3.75**	**3.40**	L-12-OV-12	**10**	**8**	**7.50**	**6.80**
15	17.0 ± .5	L-6-OV-15	**5**	**4**	**3.75**	**3.40**	L-12-OV-15	**10**	**8**	**7.50**	**6.80**
20	22.8 ± .7	L-6-OV-20	**5**	**4**	**3.75**	**3.40**	L-12-OV-20	**10**	**8**	**7.50**	**6.80**
24	27.8 ± .8	L-6-OV-24	**5**	**4**	**3.75**	**3.40**	L-12-OV-24	**10**	**8**	**7.50**	**6.80**
28	31.9 ± 1.0						L-12-OV-28	**10**	**8**	**7.50**	**6.80**
30	33.5 ± 1.0						L-12-OV-30	**10**	**8**	**7.50**	**6.80**

NOM SUPPLY VOLTAGE (VOLTS)	TRIP POINT VOLTAGE[A] (VOLTS)	20 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000	35 AMP MODELS	PRICE QTY 1	QTY 100	QTY 250	QTY 1000
5	6.6 ± .2	L-20-OV-5	**$14**	**$11.20**	**$10.50**	**$9.50**	L-35-OV-5	**$18**	**$14.40**	**$13.60**	**$12.30**
6	7.3 ± .2	L-20-OV-6	**14**	**11.20**	**10.50**	**9.50**	L-35-OV-6	**18**	**14.40**	**13.60**	**12.30**
12	13.7 ± .4	L-20-OV-12	**14**	**11.20**	**10.50**	**9.50**	L-35-OV-12	**18**	**14.40**	**13.60**	**12.30**
15	17.0 ± .5	L-20-OV-15	**14**	**11.20**	**10.50**	**9.50**					
20	22.8 ± .7	L-20-OV-20	**14**	**11.20**	**10.50**	**9.50**					
24	27.3 ± .8	L-20-OV-24	**14**	**11.20**	**10.50**	**9.50**					
28	31.9 ± 1.0	L-20-OV-28	**14**	**11.20**	**10.50**	**9.50**					

[A] VOLTAGE TOLERANCE MAINTAINED OVER 0-71°C DUE TO POWER DESIGN

[B] FOR L-6-OV-5 ONLY

SPECIFICATIONS OF LN SERIES

DC Output

Voltage range shown in tables

Regulated Voltage

egulation, line	0.1% (0.15% for LNS-Z)
egulation, load	0.1% (0.15% for LNS-Z)
ipple and noise	1.5mv RMS, 5mV pk-pk with either positive or negative terminal grounded.
temperature coefficient	0.03% /°C
remote programming resistance	200 ohms per volt nominal
remote programming voltage	volt per volt

AC Input

line	105-127 VAC, 210-254 VAC (by transformer tap change) 47-440 Hz. Consult factory for operation at frequencies other than 57-63 Hz.
Efficiency (Typical) . .	30%-5V and 6V models, 42% 12V and 15V models, 49%-20V, 24V and 28V models.

Ambient Operating Temperature Range

Continuous duty from 0° to +71°C with corresponding load current ratings for all modes of operation.

Storage Temperature Range

–55°C to 85°C

Overload Protection

Electrical

External overload protection, automatic electronic current limiting circuit limits the output current to a preset value, thereby providing protection for the load as well as the power supply.

Thermal

Thermostat – automatically reset when overtemperature condition is eliminated.

Overshoot

No overshoot on turn-on, turn-off or power failure.

Overvoltage Protection

Overvoltage protection module crowbars output when trip level is exceeded – standard on all 5V models. For other models see accessories.

Input and Output Connections

Heavy-duty screw terminals on printed circuit board.

DC Output Controls

Simple screwdriver adjustment over the entire voltage range.

Remote Sensing

Provision is made for made for remote sensing to eliminate effect of power output load resistance on DC regulation.

Mounting

Three mounting surfaces, three mounting position.

Convection Cooled

No external heat sinking or forced air required.

Transformer

MIL-T-27C, Grade 6; Electrostatic shield; 4000 VAC input/output isolation.

Isolation Rating

Minimum 10 meg-ohm isolation from DC to ground at 1000 VAC.

Fungus Proofing

All fungus nutrient components are rendered fungi inert with MIL-V-173 varnish.

Physical Data

Package Model	Weight Lbs. Net	Weight Lbs. Ship	Size Inches
LN-Z	3	3-1/4	4-7/8 x 4 x 1-3/4 (with cover) 4-7/8 x 4 x 1-5/8 (without cover)
LN-Y	5	5-1/2	5-5/8 x 4-7/8 x 2-5/8 (with cover) 5-5/8 x 4-7/8 x 2-1/2 (without cover)
LN-X	7-3/4	8-1/4	7 x 4-7/8 x 2-7/8 (with cover) 7 x 4-7/8 x 2-3/4 (without cover)

Finish

Gray, Fed. Std. 595 No. 26081.

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Designed for listing in UL Recognized Components Index.

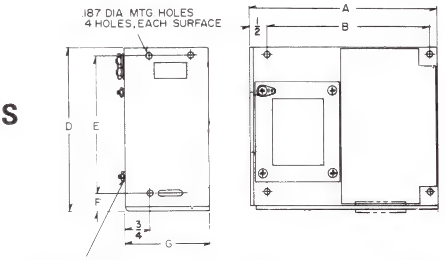
Designed for listing in VDE Index.

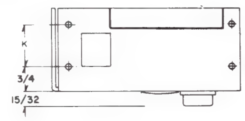
Guaranteed for 5 Years

5-year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

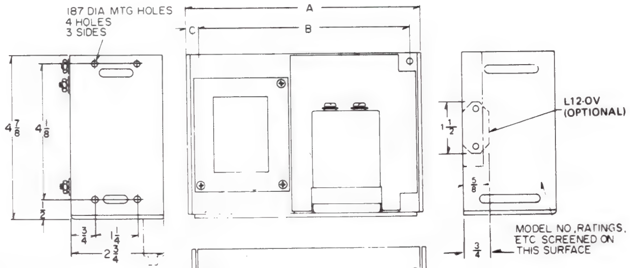
DIMENSIONAL DRAWINGS

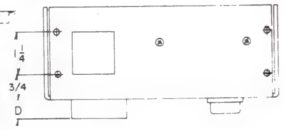
LN-Z and Y SERIES





MODEL	DIMENSIONS A	B	D	E	F	G	H	K
LN-Z	4-7/8	4-1/8	4	3-3/8	3/8	1-5/8	0	0
LN-Y	5-5/8	4-7/8	4-7/8	4-1/8	1/2	2-1/2	1-1/4	1-1/4





LN-X SERIES

MODEL	DIMENSIONS A	B	C	D	E
LN-X	7	6-1/4	3/8	1/2	7/16

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The Lambda Five-Year Guarantee on LN Series Power Supplies covers labor and all materials (except fuses) when returned to the factory. If the customer chooses to perform the maintenance, Lambda will supply all replacements for defective components without cost.

The Lambda 5-Year Guarantee covers the operation of the LN Power Supply for five years to published specifications. If, at any time during the five-year period the supply does not meet the published specification when used within specified ratings, it can be returned to the factory for calibration. Contact the nearest Lambda office before returning equipment. Shipments must be prepaid and include reason for return.

If the unit is sold to a manufacturer who is using it in a system, which he is reselling, the complete guarantee is transferable — as long as the Lambda power product is sold as original equipment.

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Test kit determines Gunn-diode threshold parameters

John L. Heaton
Microwave Associates, Burlington, MA

The threshold voltage of a Gunn diode is probably the single most important diode parameter, since threshold voltage easily relates to device active-region thickness, and therefore to operating frequency.

As shown in **Fig. 1,** my method employs a commercial DVM with BCD output to sense the diode operating current during application of a ramp voltage. TTL-logic circuits, driven by the DVM's BCD output, first sense the onset of current drop (back of threshold) and trigger the reading-retention circuitry of the DVM. A second DVM, monitoring the voltage across the diode, then triggers to retain its reading when the current drop-back is sensed. In addition, when a threshold condition is determined, the ramp generator resets to zero output, and awaits a trigger command from an operator-controlled reset switch, allowing insertion of the next diode into the test jig.

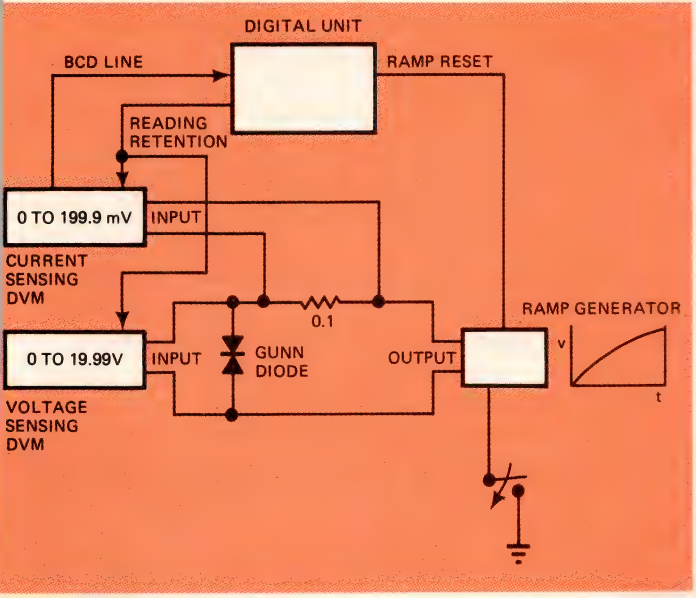

Fig. 1—Measure threshold voltages of Gunn diodes simply, quickly, and automatically without the worry of self-heating errors common to other techniques. The only major piece of equipment required is a commonplace DVM.

A detailed circuit diagram of the digital section along with the timing waveforms appears in **Fig. 2.** A clock waveform is obtained from the current-sensing DVM. In the case of the Digitec 271A-1N used here, the ramp-gate signal was obtained from internal test-point 1 (TP1) and brought out to an unused pin on the rear connector.

Fig. 2b shows how this DVM samples at line frequency, and then counts during the positive cycle of the square wave present at TP1. During the negative cycle, the resulting count is displayed. An overlap of at least one msec into the positive cycle occurs before counting begins again. Parallel BCD data is available at a rear connector on N-option meters. This data, including the error bit, acts as input to four type-SN7475 quad latches and to the A inputs of four serially connected SN7485 4-bit magnitude comparators. The latches serve as temporary storage elements and allow comparison of the previous count with the count one clock pulse (one cycle of the ramp-gate waveform) later. The Q output of the latches serves as B input to the comparators.

As shown in **Fig. 2b,** the latch clock pulse occurs three msec after the trailing edge of the ramp gate, insuring that the latch data does not update during counting. Within this period (before occurrence of the latch clock pulse), the latch output (the $t-1$ data) can be compared with the present value of the BCD line. This is accomplished by routing the $A < B$ output of the comparator string through a pair of NAND gates (each 1/3 of a SN7410). NAND$_1$, the controlling gate, drives the store inputs of the two DVM's through a pair of emitter followers. The output of NAND$_1$ cannot switch to a LOW state (and store the DVM displays) unless an enable pulse, generated by multivibrator 1, appears at one input of NAND$_3$. Thus, the comparison is enabled only during the 3-msec period following the trailing edge of the ramp-gate pulse, but prior to updating of the data stored in the latches.

When a threshold condition occurs, the t_n-1 current value stored in the latches is greater than the t_n current reading present on the BCD line, so the condition $A<B$ is true. Thus, the $A<B$ output of the comparator chain switches to a HIGH

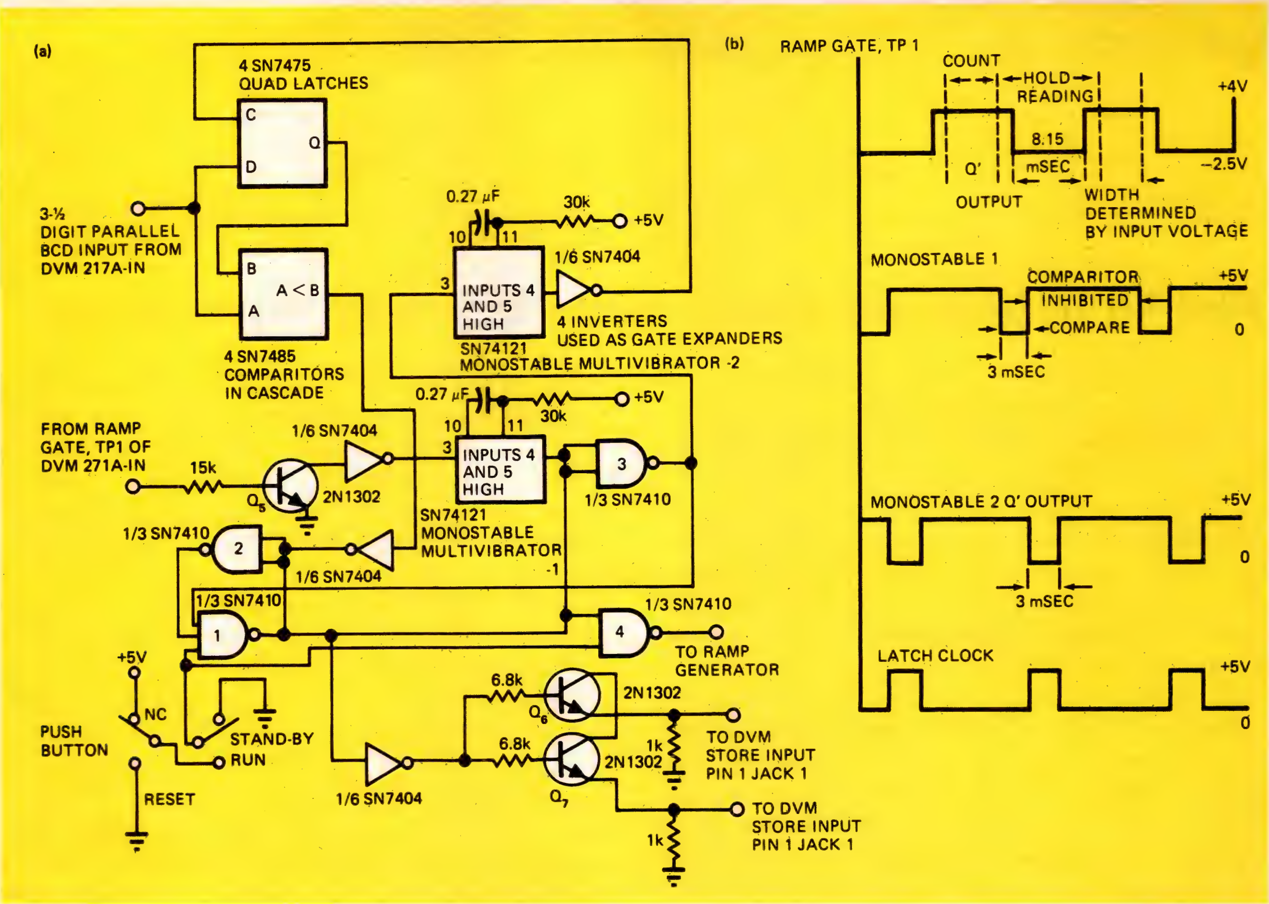

Fig. 2—Digital-section schematic and timing diagram of the measurement unit should let you build and debug the device with few problems. The DVM samples at line frequency, counting during the positive cycle and displaying information during the negative cycle.

condition. Prior to this (at time t_n), the output of $NAND_1$ was HIGH.

$NAND_2$, (also HIGH), now switches to LOW at time t_n+1. The comparison enables when monostable multivibrator 1 triggers and its Q_1 output goes LOW, while the output of $NAND_3$ switches to a HIGH state. If the operate-standby switch is in the RUN position and the reset push button released (NC position), all inputs to $NAND_1$ go HIGH and its output switches LOW. $NAND_2$ and $NAND_3$ then go into a lock-up state. Since they each now have one LOW input and hence one HIGH output, this guarantees that all inputs to $NAND_1$ remain HIGH.

$NAND_4$ now also has one LOW input, and its output switches to a HIGH state, driving the output of the ramp generator back toward zero volts. The readings on the two DVM's are stored because a HIGH condition is applied to the storage terminal. Momentarily pressing and releasing the reset push button restores original conditions and initiates another ramp. $NAND_4$ insures resetting of the ramp generator no matter when the reset button is pressed.

The ramp generator **(Fig. 3)** operates by charging a 150-µF capacitor through a trimpot to a voltage determined by an external supply. Q_1 and Q_2 allow the digital section to control the start of the ramp. Transistors Q_3 and Q_4, operating in a Darlington connection, drive the Gunn diode. In operation, the external supply voltage adjusts to about 2.5 times the expected threshold voltage, providing a fairly linear ramp up to the threshold.

The sampling rate of the DVM (used to monitor the current) limits the speed of the threshold-voltage determination. Because the actual readings recorded are not the threshold readings but rather the readings one clock pulse after threshold, the indicated threshold current will always be slightly lower than the actual threshold current, while the indicated threshold voltage will be slightly higher than the actual threshold voltage.

When using DVM's that sample at line frequency, a 2-sec measurement time will result in 2% error in threshold voltage or current. In the case of high-current diodes, self heating introduces additional error: The slower the rate of rise of the current/voltage ramp, the lower the measured threshold current, because a higher operating temperature is reached.

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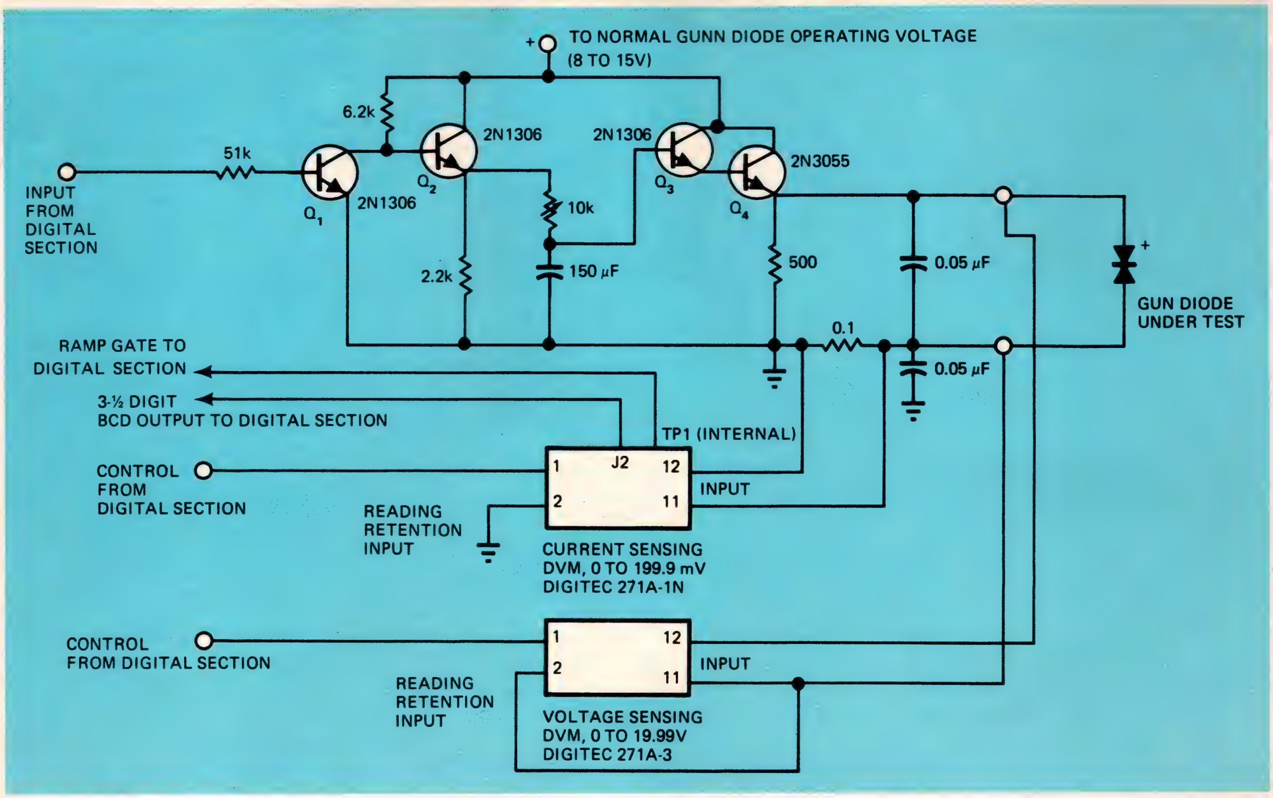
+ TO NORMAL GUNN DIODE OPERATING VOLTAGE (8 TO 15V)
6.2k
2N1306
2N1306
2N3055
51k
INPUT FROM DIGITAL SECTION
Q1
2N1306
Q2
10k
Q3
Q4
2.2k
150 μF
500
0.05 μF
+
GUN DIODE UNDER TEST
0.1
RAMP GATE TO DIGITAL SECTION
0.05 μF
3-½ DIGIT BCD OUTPUT TO DIGITAL SECTION
TP1 (INTERNAL)
CONTROL FROM DIGITAL SECTION
1
J2
12
2
11
INPUT
READING RETENTION INPUT
CURRENT SENSING DVM, 0 TO 199.9 mV DIGITEC 271A-1N
CONTROL FROM DIGITAL SECTION
1
12
2
11
INPUT
READING RETENTION INPUT
VOLTAGE SENSING DVM, 0 TO 19.99V DIGITEC 271A-3

Fig. 3—Ramp generator with associated circuitry receives control signals from the digital section of **Fig. 2.** It operates by charging a capacitor to an externally determined voltage.

Knowing the approximate threshold of the diodes to be tested permits additional measurement speed. Adjusting the ramp-generator time constant to about 1/4 sec and using an external supply voltage only slightly above the expected threshold voltage allows one to locate the slowly rising tail of the exponential-voltage RC ramp at the threshold point. The more rapid initial rise results in a reduced measurement time. With this technique, a measurement time of about one sec is possible with a ±2% maximum error. Additional measurement speed is not normally required if diodes are hand-loaded into the test fixture. When because of machine loading additional test speed is desired, the ramp-generator circuit could be modified to allow decay of the ramp voltage to just below threshold rather than to zero volts. ▭

To Vote For This Circuit
Circle No. 326

This flame detector interfaces directly to a μP

Alan Ames
Fisher Scientific Company, Waltham, MA

Many flame detectors utilize a gas-diode tube that conducts when exposed to the ultraviolet OH vibrational bands present in a flame. Although this photoionization is quite strong, a high voltage must still be applied to the tube to detect the ionization.

The flame detector defined here, however, takes advantage of the near IR bands located near the peak response of a silicon Darlington phototransistor. A filter reduces the interferences from visible light sources. This very sensitive circuit can thus pick up hydrogen flames which emit no visible light.

Shown in **Fig. 1,** the circuit operates as a Schmitt-trigger type—except that the base current rather than the base voltage controls Q_2. R_2 and R_4 are chosen so that the circuit output can drive a TTL load and also determine the triggering point of the input light level. R_1, R_3 and R_5 must bias Q_3 ON when Q_1 is below the desired triggering level. They must also provide the

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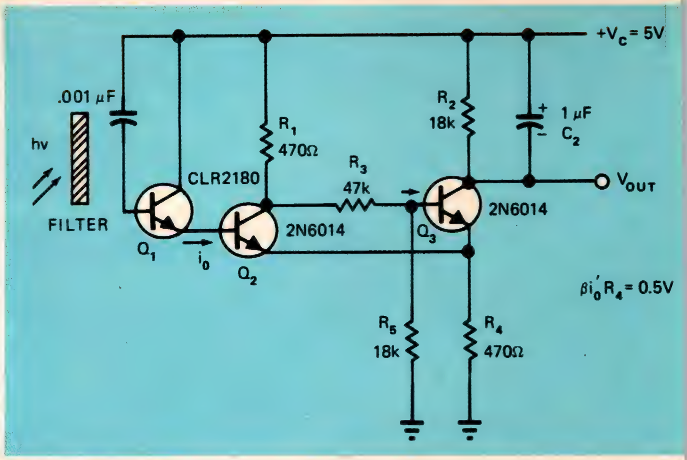

Fig. 1—This flame detector provides a high-level output upon detecting a flame. Capacitor C_1 provides base drive during momentary flame flickering to maintain Q_1 in conduction.

proper positive feedback for hysteresis.

The equivalent circuit in **Fig. 2** serves to find the proper values of R_1, R_2 and R_5 for positive feedback. If R_1 is set equal to R_4, the small signal gain is negative and hysteresis is attained. But even with hysteresis, the flickering of a flame can become extreme. Thus, C_1 is added to maintain a base charge on Q_1, the photodarlington, so that it will conduct even if no light falls on it momentarily. C_2 filters out periodic noise spikes from interfering light sources that could give false readings.

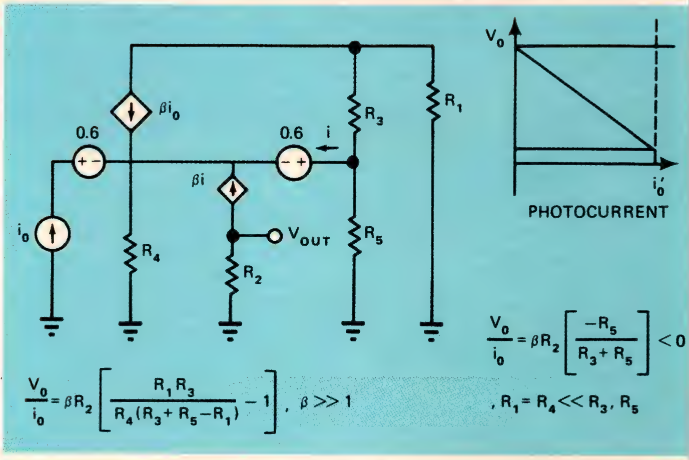
V$_0$
βi$_0$
0.6
0.6
i
R$_3$
R$_1$
βi
i$_0$
R$_4$
V$_{OUT}$
R$_2$
R$_5$
i$_0$'
PHOTOCURRENT
$\frac{V_0}{i_0} = \beta R_2 \left[\frac{-R_5}{R_3 + R_5}\right] < 0$
$\frac{V_0}{i_0} = \beta R_2 \left[\frac{R_1 R_3}{R_4 (R_3 + R_5 - R_1)} - 1\right]$, $\beta >> 1$
, $R_1 = R_4 << R_3, R_5$

Fig. 2—In this equivalent circuit, if R_1 equals R_4, hysteresis helps overcome flickering.

Finally, this circuit does not require a special high voltage, costs less than a gas diode (only under direct sunlight does a gas diode provide a better signal-to-noise ratio), and its output can go directly to the input port of a microprocessor. ☐

To Vote For This Circuit
Circle No. 327

Design Entry Blank

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Date__________________________

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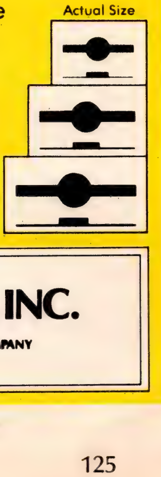

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DAC 80: 12 bit DAC's price cut by half. *The DAC 80 is a truly self-contained D/A converter with guaranteed montonicity. It includes internal reference source, output buffer amplifier, maximum non-linearity of ± ½LSB, and a price of only $19.50 (in 100's).*

3650/3652 Isolation Amp: Breakthrough in price and size. *Thanks to a new optical coupling technique, you now have a low cost alternative. Under one cubic inch in volume, the 3650HG, with 0.3% gain non-linearity and 1500V continuous isolation is only $26.50 (in 100's).*

3626 Instrumentation Amp: Modular performance at lower cost. *The laser-trimmed 3626 family offers the performance you need. Input offset drift as low as 1 μV/°C at G = 1000, <2μV/°C at G = 5, gain non-linearity is 0.01%. Prices start at $13.00 (in 100's).*

4127 Log Amp: Low-cost solution to signal processing problems. *4127 is the first hybrid log amp to accept inputs of either polarity—up to 4 decades of voltage or 6 decades of current input. It functions as a logarithmic, log ratio, or antilog amplifier, and is only $26.00 (in 100's).*

Five circuits—*typical examples of Burr-Brown's commitment to cost savings. Over the past year, Burr-Brown has cut prices on a substantial number of products, some by more than 50%.*

To find out more on how Burr-Brown can help you meet those crucial cost vs. performance specifications, write or call: Burr-Brown, International Airport Industrial Park, Tucson, Arizona 85734. (602) 294-1431.

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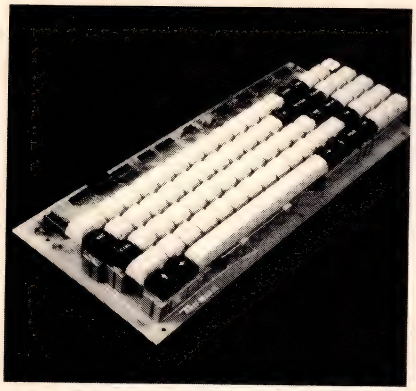
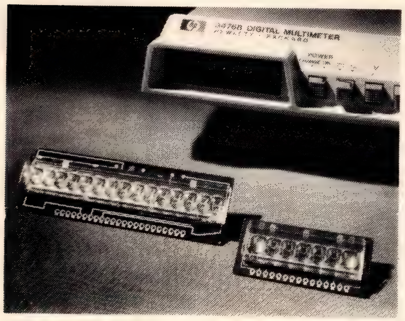
COMPONENTS/PACKAGING

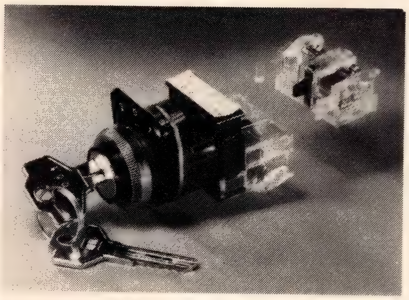


S.S. KEYBOARD. Tested in excess of 100 million operations without failure, the Cap-Tron™ solid-state keyboard uses noncontacting capacitive switches. Their capacitance change is 7× greater than required for dependable switching. Both standard and custom configurations—plus options that include 2-key or N-key rollover, selection of operating force, and many choices of keytop shapes, colors, legends and languages—are offered. ASR-33 version, $100. **The Maxi-Switch Co.,** 9697 E. River Rd., Minneapolis, MN 55433. Phone (612) 755-7660. **Circle No. 172**



LED DISPLAYS. Monolithic and drawing only 2 mA/segment, the 0.175-in.-high HP 5080−7265, −7275, −7285, and −7295 LED indicators come in 5- and 15-digit packages. Spacing of 4/in. and direct drive by MOS circuits are featured. The −7265 and −7275 versions (5- and 15-digit clusters, respectively) have a center decimal point; the corresponding −7285 and −7295, a right decimal point. All may be mounted with edge connectors or soldered wires. 5082-7265 (5 digit), $11.25 (200). **Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, CA 94304. Phone (415) 493-1501. **Circle No. 173**

DPM. Built on a single 2.9×1.4-in. pc board, Model 325 features a 3-digit 0.4-in. bright orange LED display with automatic polarity indication. Other attributes include external decimal-point selection, 1000-MΩ input impedance, ±0.1% accuracy and linearity, 7-pA typical input-bias current, T.C. of ±0.005%/°C and power consumption of 550 mW. A choice of 4 ranges (1, 10, 100, and 1000V dc) is offered. All units receive a 150-hr burn-in, and carry a 2-yr warranty. $47 (qty.). **International Microtronics Corp.,** 4016 E. Tennessee St., Tucson, AZ 85714. Phone (602) 748-7900. **Circle No. 174**

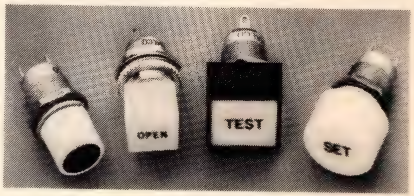


KEY-LOCK SWITCHES. Five tumbler locks provide intermediate-level security with the Series-2000 control units. Offered with a choice of either maintained or momentary keylock in 2 or 3 positions, they mount in 7/8-in.-dia. panel holes. Using 1, 2, 3 or more SNAP-BLOC contact blocks can achieve any combination of N.O. and/or N.C. contacts. UL and CSA contact rating is 10A at 300V ac (3600-VA make; 360-VA break). $8.95. **Alco Electronic Products Inc.,** 1551 Osgood St., North Andover, MA 01845. Phone (617) 685-4371. **Circle No. 175**

TEMPERATURE RECORDERS. Self-adhesive Temp-Plate recorders come in sizes as small as 0.19-in. dia., and with 1 to 8 indicators over a range of 100 to 1100°F. Their 0.01-in. max. thickness and ±1% accuracy suit them for IC's, transistors and other electronic components. Each indicator changes irreversibly from light color to black when exposed to heat exceeding its calibrated temperature. An evaluation sample is free. **William Wahl Corp.,** 12908 Panama St., Los Angeles, CA 90066. Phone (213) 822-6144. **Circle No. 176**

SWITCHABLE DELAY LINE. The Nanno Switch has individual delay lines, each with its own switch, that allow for delay increments in 1-, 2-, 4-, 8-, 16-, 32-, 64-, and 128-nsec steps. Either 50 or 75Ω versions—with or without the 128-nsec step—are available. From $62. **Allen Avionics, Inc.,** 224 E. 2nd St., Mineola, NY 11501. Phone (516) 248-8080. **Circle No. 177**

ON-DELAY RELAYS. Hybrid electronic timing relays of the 7086 Series meet UL component-magnetic motor controller guide NLDX2, and provide repeat accuracy of 2%, transient protection and switching capacity to 10A. Timing range of these 120V, 60-Hz units is from 1 sec to 2 min. in ambient temperatures from −10 to +55°C. Each relay has 0.1-sec reset time, with electrical life at full load rated >100,000 operations. From $13. **Cutler-Hammer, Inc.,** 4201 N. 27th St., Milwaukee, WI 53216. Phone (414) 442-7800. **Circle No. 178**



INDICATOR LIGHTS. Subminiature (incandescent) lights in a wide choice of solid colors and 2-tone effects come either front-mount in 15/32-in. holes, or front- and back-mount in 1/2-in. ones. All use T-1-3/4 midget flange-base lamps (1.35 to 28V). Round, square and rectangular caps can be specified in 6 colors and with hot-stamped or engraved legends. From $1.26 (1000). **Dialight,** 203 Harrison Pl., Brooklyn, NY 11237. Phone (212) 497-7600. **Circle No. 179**

THUMBWHEEL SWITCH. The subminiature T50J-01M has 1/2-in., J-shaped pin terminations attached, making it readily adaptable for motherboard or wire-wrap applications. This matte-finished, 10-position decimal thumbwheel has inline readout and modular construction that allows ganging in minimum space. A 40-switch assembly, for example, uses a panel opening only 3/4 in. high and <13 in. wide. With 11 J-pins installed, $4.90. **Cherry Electrical Products Corp.,** 3600 Sunset Ave., Waukegan, IL 60085. Phone (312) 689-7702. **Circle No. 180**

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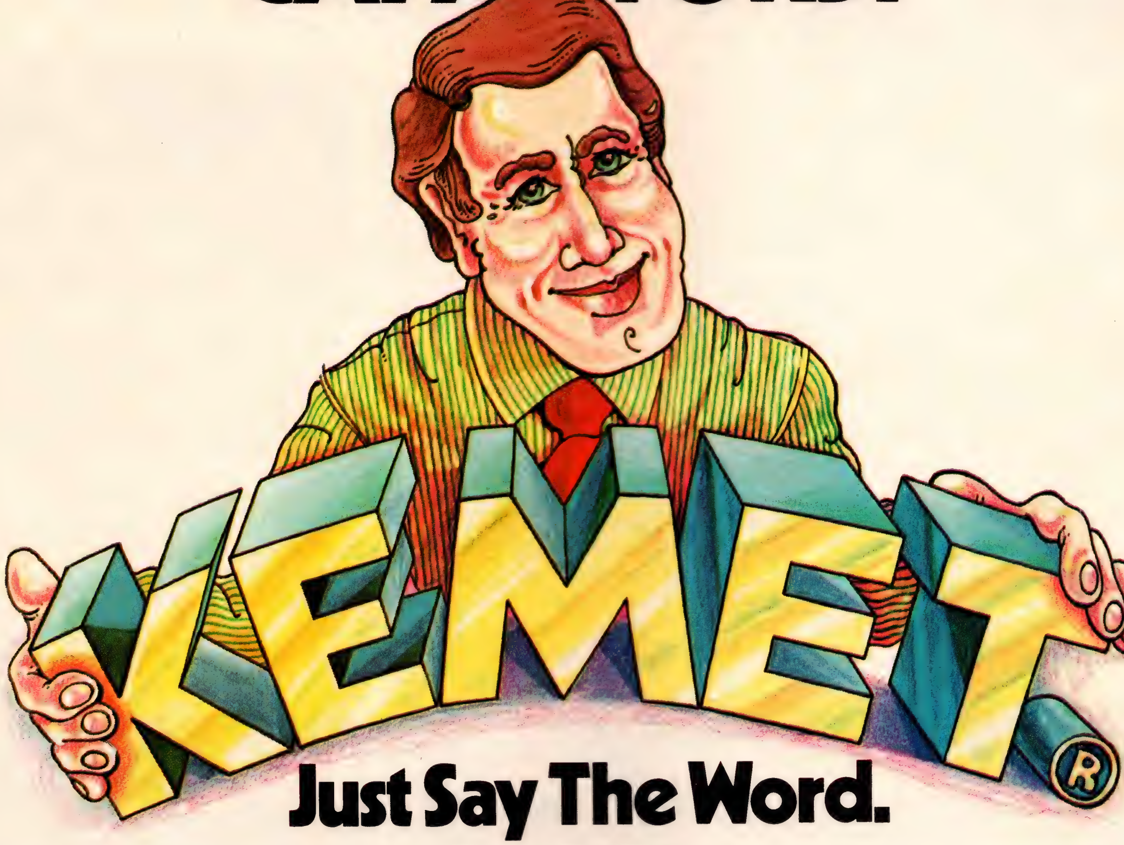

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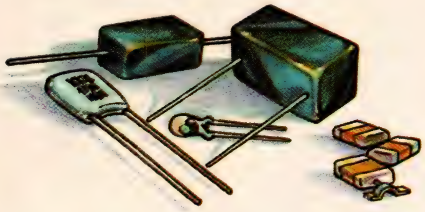

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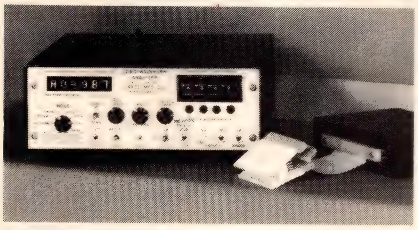
INSTRUMENTATION/POWER SOURCES

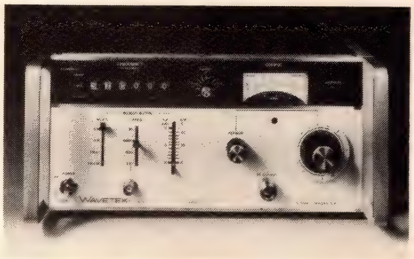


LOGIC/WAVEFORM ANALYZER. Model DM 230 allows data-domain analysis of a microcomputer using the 32-bit wide by 128-word long built-in memory system. A 4-digit hexadecimal thumbwheel switch sets the start- or end-trigger address, and stored data is displayed on a 6-digit hexadecimal display. The waveform-analysis capability allows a real-time analog scope presentation of the microprocessor data, address, or status lines. $2900, with 1 probe buffer. Delivery, 60 days ARO. **Davco Manufacturing Co.,** 169 Ridgedale Ave., Morristown, NJ 07960. Phone (201) 267-4990. **Circle No. 221**

TRANSIENT DETECTOR. The ZAP-TRAP detects and measures transient voltages of 10 to 1000V on ac or dc lines. Battery powered for isolation, it traps transients as fast as 2 μsec. Readout is with the user's 0-10V dc VM (10-kΩ/V impedance or greater). Peaks are held for at least 15 min. with <10% decay. $75 (batteries extra). **Industrionics, Inc.,** 115 Pleasant St., Millis, MA 02054. Phone (617) 376-8147. **Circle No. 222**

X-Y DISPLAY. With its 12-in. (diagonal) nonglare CRT, Model SD311 presents bright, undistorted spectra from real-time analyzers and FFT signal processors. Linear and logarithmic inputs may be instantly selected on both the spectrum and frequency axes, and Z-axis input is provided. Retrace blanking and raw input (time-history) are also switch-selectable. $3250. **Spectral Dynamics Corp.,** Box 671, San Diego, CA 92112. Phone (714) 565-8211. **Circle No. 223**

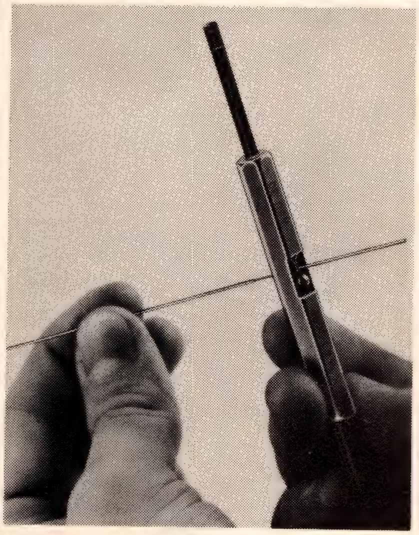
SPECTRUM ANALYZER. Its IEEE-488/1975 digital interface allows the FFT 512/S-15 to be controlled by a minicomputer, a terminal, or other programmer/controller that uses the IEEE-standard interface. The external device can then read from, and write into, any location in the memory of the FFT 512/S. $8900. Delivery, 60 days ARO. **Rockland Systems Corp.,** 230 W. Nyack Rd., West Nyack, NY 10994. Phone (914) 623-6666. **Circle No. 224**

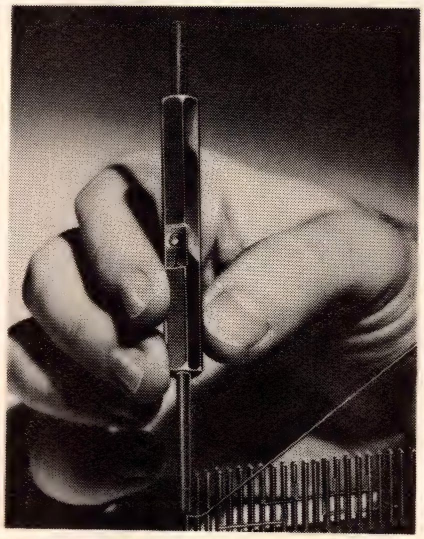


SIGNAL GENERATOR. Model 3001, a 1-520 MHz programmable synthesized signal source features CW, AM and FM operation with internal 400- and 1000-Hz (or external) modulation capabilities. Frequency accuracy is 0.001%; stability, 0.2 ppm/hr. A front-panel meter monitors the output power, which is adjustable from +13 to −137 dBm and is calibrated in V rms and dBm. $2600. **Wavetek Indiana, Inc.,** 66 N. First Ave., Beech Grove, IN 46107. Phone (317) 783-3221. **Circle No. 225**

IN WIRE-WRAPPING ok HAS THE LINE...

HOBBY-WRAP-30


STRIP


WRAP

UNWRAP

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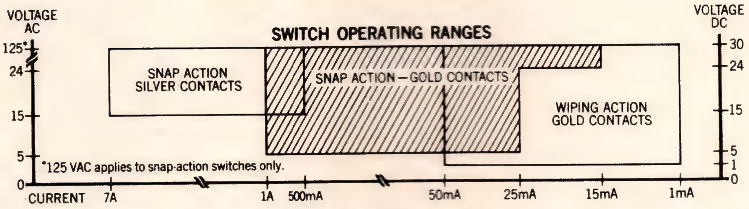
Dialight Switches

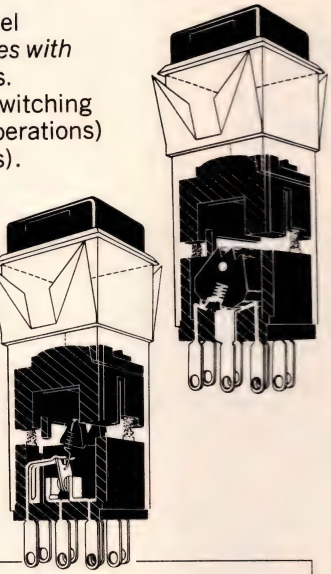
A switch for all reasons.



Reason 1: Dialight offers three switch configurations to meet all your needs—*snap-action switches with silver contacts* for moderate-level applications, *snap-action switches with gold contacts* for intermediate-level applications, and *wiping-action switches with gold contacts* for low-level applications. Each of these ranges is served by two switching actions—momentary (life: 750,000 operations) and alternate (life: 250,000 operations).

Reason 2: Dialight's snap-action and wiping-action switches come in a new modular design concept . . . a common switch body for either high or low current operation. All 554 series switches and matching indicators have the same rear-panel projection dimensions.

The snap-action switching mechanism guarantees a fast closing and opening rate. This insures that contact force and contact resistance are independent of the switch's actuation speed.



In the wiping-action switch, the contacts are under constant pressure (A unique Dialight design). This insures long life with a minimum build-up of contact resistance.

Both switch types are tease-proof.

PRODUCT SELECTOR GUIDE

SWITCHING ACTIONS	Snap-Silver contacts		Snap-Gold contacts		Wiping-Gold contacts	
	SPDT	DPDT	SPDT	DPDT	SPDT	DPDT
MOMENTARY	○	○	○	○	○	○
ALTERNATE	○	○	○	○	○	○

OPTIONS

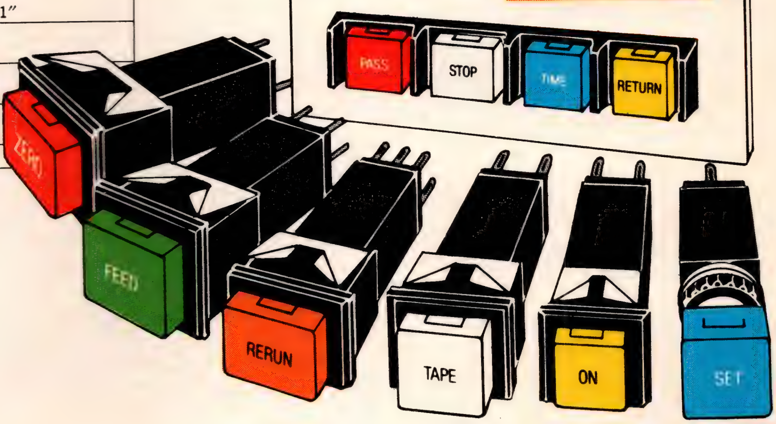
	PUSH BUTTON CAP SIZES				
	½″ Sq.	⅝″ Sq.	⅝″ x ¾″	¾″ Sq.	¾″ x 1″
BEZEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
BEZEL MOUNTING WITH BARRIERS TO ACCOMMODATE		○	○	○	○
PANEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
MATCHING INDICATORS	○	○	○	○	○

Reason 3: Dialight offers a wide variety of panel and snap-in bezel mounting switches with momentary and alternate action configurations in SPDT and DPDT types. There are over 240 switch variations to choose from.

The 554 illuminated switch, designed for front of panel lamp replacement, gives you a choice of five different bezel sizes . . . ¾″ x 1″, ⅝″ x ¾″, ¾″ square, ⅝″ square, and ½″ square. The first four sizes are also available with barriers. You also get a choice of six cap colors . . . white, blue, amber, red, green, and light yellow . . . four different underlying filter colors . . . red, green, amber, and blue and a variety of engraved or hot-stamped legends . . . over 300 cap styles . . . over 100,000 combinations.

There is also a variety of terminal connections . . . solder blade, quick connect, and for PC board insertions.

Reason 4: Dialight's 554 series is designed as a *low cost switch with computer-grade quality.*



DIALIGHT
A North American Philips Company
203 Harrison Place, Brooklyn, N.Y. 11237
(212) 497-7600

For more information, Circle No. 67

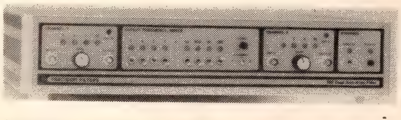
INSTRUMENTATION/POWER SOURCES

DIGITAL TROUBLESHOOTERS. A 3-instrument kit, Model 5021A contains the 545A multifamily logic probe, the 546A logic pulser and a 548A logic clip. These provide stimulus-response testing for $375. The Model 5022A advanced kit adds the 547A current tracer for following current pulses directly to the faulty circuit component, and sells for $700. Finally, Model 5023A adds Model 10529A logic comparator that allows "mapping" of faulty logic responses. $1200. **Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, CA 94304. Phone (415) 493-1501. **Circle No. 226**

MODULAR SUPPLY. Rated for 150,000-hr MTBF, Model DPS5S500 delivers 5V at 0.5A from a 2.5×3.5×0.875-in. package. Specs show 71°C operation, output ripple and noise of 1 mV rms, and input of 105-125V, 50-440 Hz. $31.95; $26 (10). **Semiconductor Circuits, Inc.,** 306 River St., Haverhill, MA 01830. Phone (617) 347-0269. **Circle No. 227**

POWER SUPPLY. The CM series of modular supplies has its barrier-strip connections recessed within the case outline. Molded-in, threaded inserts permit bolting to a metal chassis if desired. This series includes 5V/1A; ±12V/200 mA; ±15V/50, 100 or 200 mA; and 2 triple-output versions delivering ±12 or ±15V and 5V. All are housed in a 4×2.7×1.4-in. case. $39 to $95. **Calex Mfg. Co., Inc.,** 3305 Vincent Rd., Pleasant Hill, CA 94523. Phone (415) 932-3911. **Circle No. 228**

CAPACITANCE STANDARD. Seven ranges covering from 1 μF to 1F in decade steps, 0.25% accuracy and a D of 0.01 at 100 Hz, 120 Hz and 1 kHz make the 4-terminal GR 1417 a convenient standard for large capacitance values. Useful frequency range is from <50 Hz to >10 kHz. $775. **GenRad, Inc.,** 300 Baker Ave., Concord, MA 01742. Phone (617) 369-4400. **Circle No. 229**



ANTI-ALIAS FILTER. Both dual and programmable, Model 602 has a pair of independently programmable, elliptic low-pass filters that cover from 10 Hz to 150 kHz in steps of 1 from 1 to 15 in each decade range. Also independently programmable, gain and overload detectors are provided in each channel, as well as 3 computer-compatible control options for direct interface with a minicomputer or controller. $2850. **Precision Filters, Inc.,** 303 W. Lincoln St., Ithaca, NY 14850. Phone (607) 277-3550. **Circle No. 230**

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ALUMINUM FOIL TRANSFORMERS

If you're looking for an isolation or autotransformer with...

- Single or multiphase
- Reduced size and weight
- Higher temperature operation
- Improved thermal efficiency
- Higher electrical efficiency, and better regulation

...then our aluminum foil transformer line could be your answer. Units are available in 50/60 Hz, 400 Hz and higher frequencies, in sealed, shell and open-frame versions, with ratings to 5000 VA and outputs through 500 volts. Or send us your requirements for a design and price proposal. Send for our transformer data sheet and technical bulletin today to Electrocube, 1710 So. Del Mar Ave., San Gabriel, CA 91776; (213) 573-3300.

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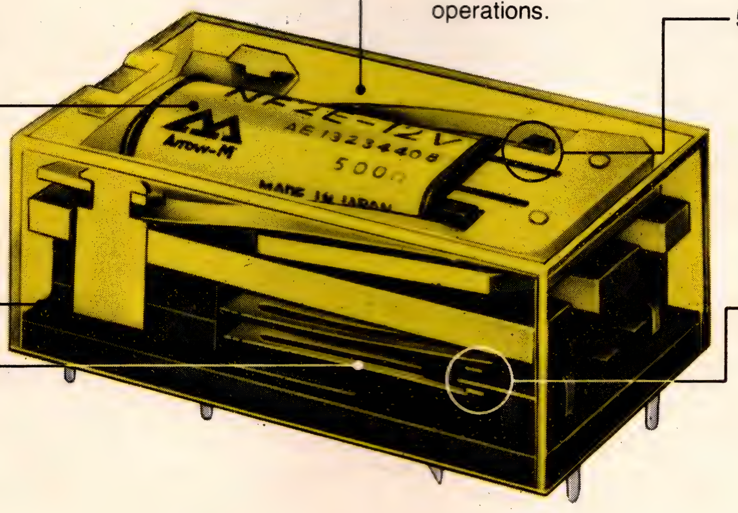
Arrow-M Amber Relays



1. High Sensitivity
Minimum operating power NF2E 190mw, NF4E 310mw.

2. Plastic Sealed
With N_2 gas enclosed.

3. High Contact Capacity
2 amps @ 30VDC resistive. Can switch up to 220V AC/DC. Available in 2C, 4C and Form D (MBB) contacts.

4. Long Life
10^8 mechanical operations.

5. Negligible Chattering
Lift-off card system and rebound absorbing structure minimizes contact bounce.

6. Low Stable Contact Resistance
Bifurcated gold clad lift off contacts. Applicable to low level circuits.

Sound advice for the alarm industry.

You know better components make a better alarm system. So it pays to install the most reliable relays available today: Arrow-M NFE Amber Relays . . . supported by our unique and advanced manufacturing techniques. They offer you:
Reliability — The secret is a unique automated modular assembly coupled with lift off bifurcated contacts and a rebound absorbing mechanism. Installed in a sensitive alarm, it can go unused for long periods of time and still work when needed.
Sensitivity — NFE Amber Relays use only half the power of ordinary relays.
Automatic Wave Soldering — NFE Amber Relays are plastic sealed with N2 gas.
High Packaging Density PC Board Mounting — flatpack NFE Amber Relays are only 0.425 inches high.

The proven dependability and sensitivity of Arrow-M Amber Relays is based on more than 50 years of meeting the advancing needs of modern technology. So for relays that make it easier to make a better alarm, rely on Arrow-M NFE Amber Relays.

Relays for Advanced Technology

For evaluation samples, or for more information on exact specifications, write or call your nearest Arrow-M office.

Arrow-M Corporation
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Mountainside, N.J. 07092
(201)232-4260

Western Office:
22010 S. Wilmington Ave.
Suites 300 & 301
Carson, Calif. 90745
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NOW-IT'S HERE!
BY POPULAR DEMAND
Full Four-Digit DMM
With Rechargeable Batteries & Charger Unit **$190**

Another Volksmeter— **LM-40**

Features Include:

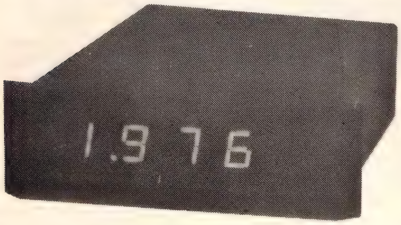
- Super Rugged - ideal for field service use. • Accuracy - 0.1%. • 19 ranges: 4 vdc, 4 vac, 5 ohms and 6 current (optional). • Automatic zeroing and polarity. • Full four digits enhances low ohms measurement. • Small size: 1.9" H x 2.7" W x 3.9" D. • Fully protected input.

Also a 1%, 3-digit LM-3 @ $125, a 1%, 3-1/2-digit LM-3.5 @ $147 and a 0.05%, 4-digit LM-4 @ $227.

See your local distributor!
Distributor inquiries invited.

For more information, Circle No. 70

AC PANEL METER



PM-3.5AC $136

Features Include:

- Full three digits plus 100% over-range (3-1/2 digits). • ±0.5% reading ±2 digits accuracy from 45 Hz to 1200 Hz (45 - 400 Hz for 1000V range).
- 2V, 20V, 200V or 1000V full scale ranges.
- Operates from +3.6 to +6V at less than 250 mA.
- Programmable decimal. • Small size: 1" H x 2.5" W x 3.75" D. • Large 0.3" LED display.
- Multiplexed BCD output. • Ratio or voltmeter operation.

Also vdc meters - a unipolar or bipolar, 0.1%, 3-digit PM-3 or PM-3A @ $85 or $89; a bipolar, 0.05%, 3-1/2-digit PM-3.5 @ $99 and a bipolar, 0.02%, 4-digit PM-4 @ $170.

See your local distributor!
Distributor inquiries invited.

For more information, Circle No. 71

NLS
Non-Linear Systems, Inc.
Originator of the digital voltmeter.
Box N, Del Mar, California 92014
Telephone (714) 755-1134 TWX 910-322-1132

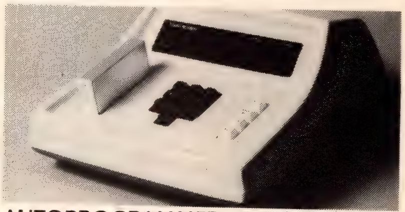
INSTRUMENTATION/POWER SOURCES

RS-232C MONITOR. Model 232 indicates the condition of the data-communications system under test, permits direct access to individual signal lines, and allows operation of the system terminal in the echo mode. The unit continuously displays DRT, CD, DSR, CTS, RTS, RD, TD, and TEST INDICATOR on 8 bright LED's. Pin connections permit scope monitoring. **Goodwood Data Systems,** Box 768, Ogdensburg, NY 13669. Phone (613) 257-3610. **Circle No. 231**

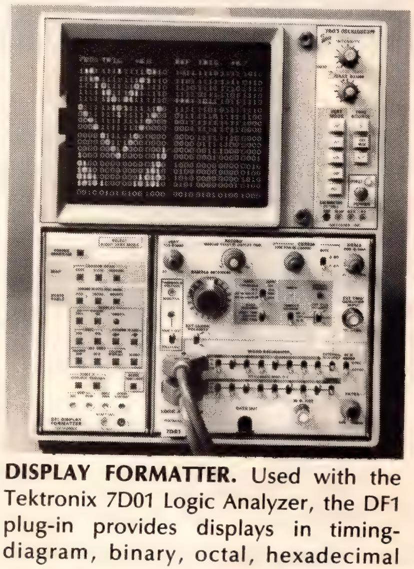
DISC EXERCISER. A series of tests ranging from simple restore operations through complex data excercises can be performed on 2315-type disc drives such as Wangco, Pertec, and Diablo by the DX-1000. Functions include restore, seek, increment or decrement up or down the disc, as well as random patterns of incrementing. $1995. **Wilson Labs., Inc.,** 2536-D E. Fender Ave., Fullerton, CA 92631. Phone (714) 992-0410. **Circle No. 232**

MINI-LAB for component and wafer testing, TP22/34 allows users to test at room temperature to 200°C with a single controller. A head accepts adapters to conform it to package configurations, while a chuck mounts on the prober for interference-free testing. Accuracy of 1%, stability of ±0.3°C and temperature gradient of <1°C across the chuck surface are provided. Delivery, 4 to 8 wks. ARO. **Temptronic Corp.,** 40 Glen Ave., Newton, MA 02159. Phone (617) 965-3420. **Circle No. 233**

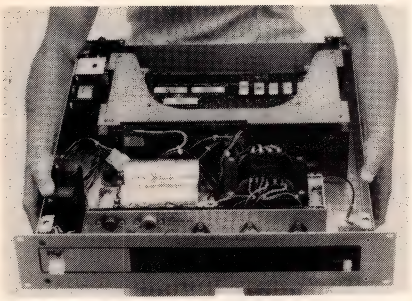
μP ANALYZER. The LOGICORDER-32, a 32-channel device, offers direct readout of hexadecimal character using a standard scope as display. Pocket sized, it triggers at a pre-set 16-bit address and stores 64 words in memory. The triggered address can also stop storage into memory, thereby showing microprocessor activity prior to triggering. $895. **Scanoptik Inc.,** Box 1745, Rockville, MD 20850. Phone (301) 977-9660.
Circle No. 234



AUTOPROGRAMMER. Model 583, an EROM for use with Wavetek programmable generators, stores a sequence of programming commands that automatically control the generator output. Up to 99 separate tests can be stored in each EROM. Test cycling can be either automatic or manual; cartridges, either user or custom programmed by Wavetek. $795. **Wavetek,** Box 651, San Diego, CA 92112. Phone (714) 279-2200.
Circle No. 235

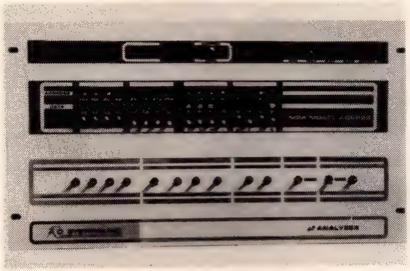


DISPLAY FORMATTER. Used with the Tektronix 7D01 Logic Analyzer, the DF1 plug-in provides displays in timing-diagram, binary, octal, hexadecimal state-table and mapping formats. Primary applications are in the development and production of software, and in the design, production, and servicing of digital hardware and firmware. $1195. Delivery, 12 wks. ARO. **Tektronix, Inc.,** Box 500, Beaverton, OR 97077. Phone (503) 644-0161. **Circle No. 236**

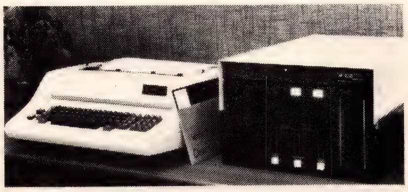


MICROCOMPUTER. Based on the SBC 80/10 single-board computer, the System 80/10 comes packaged with 1k bytes resident memory, 48 parallel and 1 serial programmable I/O lines, a system monitor, power supplies and OEM front panel. The unit's card cage and backplane assembly provide slots for 3 expansion boards with additional memory and I/O. An on-board USART gives users the option of RS-232C or 20-mA current-loop interfacing. $1495. **Intel Corp.,** 3065 Bowers Ave., Santa Clara, CA 95051. Phone (408) 246-7501.
Circle No. 181

MEMORY SYSTEM. Organized into 16,000 20-bit words (16-and 18-bit bytes also standard), the NS3000-1 crams 320k bits onto a single 11.75×15.40-in. card. Key spec's include 280-nsec access time, 430-nsec R/W cycle time and 610 nsec for a read-modify-write cycle with either synchronous or asynchronous memory refresh. The standard version requires ±15 and ±5V. Bytes of 8, 9 or 10 bits come as options. $1050 (OEM qty.). **National Semiconductor Corp.,** 2900 Semiconductor Dr., Santa Clara, CA 95051. Phone (408) 737-5000.
Circle No. 182



µP DEVELOPMENT TOOL, Model MPA AO 6800, provides hardware breakpoint and monitor, run/halt and single-step and allows users to examine registers and examine and deposit in 65k of memory. Displays show system and analyzer status, and address and data-bus contents. A Slow Memory Speed Simulator simulates the use of slower memories while an Execute control allows insertion of instructions independent of normal program flow. $695. **A O Systems Inc.,** 1736 Front St., Yorktown Heights, NY 10598. Phone (914) 962-4264.
Circle No. 183



DISC-BASED COMPUTER. The Micro File MK II is a stand-alone computer with dual, 2nd generation, 600k-character flexible discs. Of its 2 RS-232 serial I/O ports, 1 handles a data terminal, the other a data-communications line—both at independent speeds from 110 to 9600 baud. An 8k-byte RAM user memory (expandable to 56k) also comes standard. Assembler ($350) and Extended Basic ($500) software options are available. $4295. **DTC,** 1190 Dell Ave., Campbell, CA 95008. Phone (408) 378-1112.
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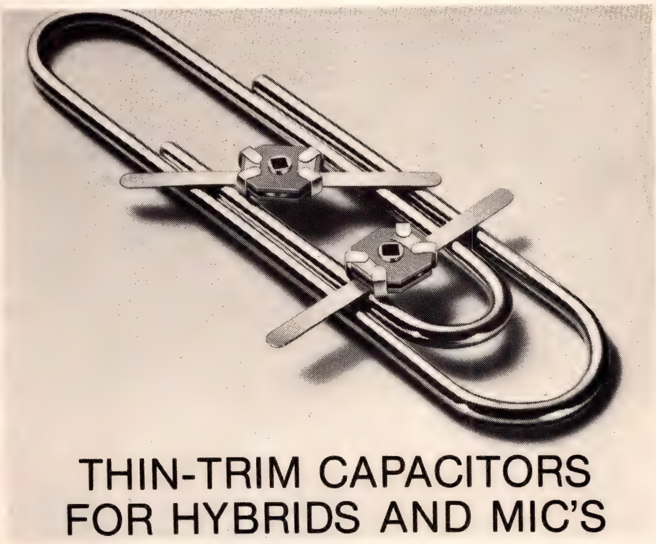

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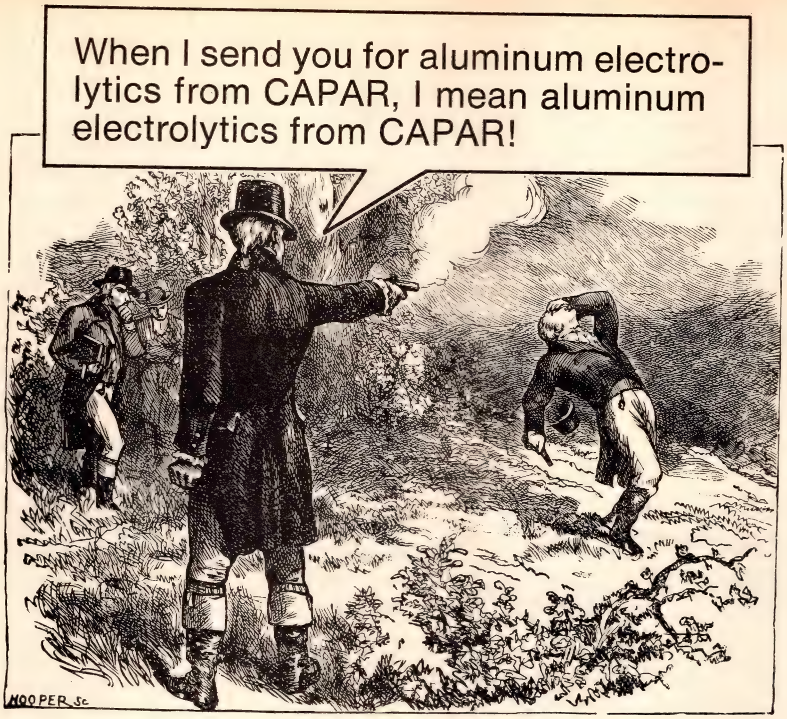
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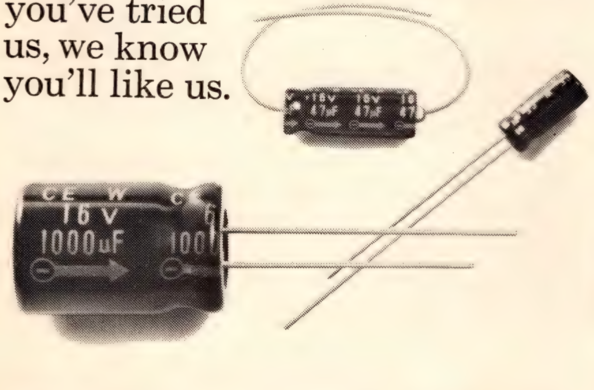

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For more information, Circle No. 74

COMPUTERS/PERIPHERALS

MICROCOMPUTER. The S/80-DSK is an 8080 software-compatible disc-based μC with a drive/controller combo capable of transferring 200k bytes/sec. A disc executive software package called S/80-DEX provides I/O drivers, symbolic debug, resident editor and assembler and file-management functions. The unit's high-speed bipolar 8080 emulator has DMA, vectored-priority interrupt, real-time clock and power failure/restart as standard. $9450 with 5M-byte disc; delivery, 60-90 days ARO. **EMM Corp.,** 12621 Chadron Ave., Hawthorne, CA 90250. Phone (213) 644-9881.

Circle No. 185

PORTABLE TERMINAL. The Model 380 "Troubleshooter" functions as a standard 10-, 15- or 30-character/sec portable terminal, yet has an operator-switchable character set that allows printing of nonprint characters such as device-control codes, tabs, etc. "Off-the-shelf" models operate on full upper-and-lower case ASCII but other codes (APL, Baudot, IBM correspondence or RS 244A) are available. The unit's built-in acoustic coupler features AT&T 103 and RS-232C compatibility. **Computer Transceiver Systems, Inc.,** E. 66 Midland Ave., Paramus, NJ 07652. Phone (201) 261-6800.

Circle No. 186

INTERFACE. This 8-bit parallel I/O board, supplying 95% of the required I/O circuitry and timing adjustment, will provide a "universal" interface for almost all mini- and microcomputers and other parallel interfaces. The board "piggy-back" plugs into the MFE 250B digital cassette transport, providing the required hardware to operate the transport and record data on the cassette in an ANSI/ECMA-compatible format. $325. **MFE Corp.,** Keewaydin Dr., Salem, NH 03079. Phone (603) 893-1921.

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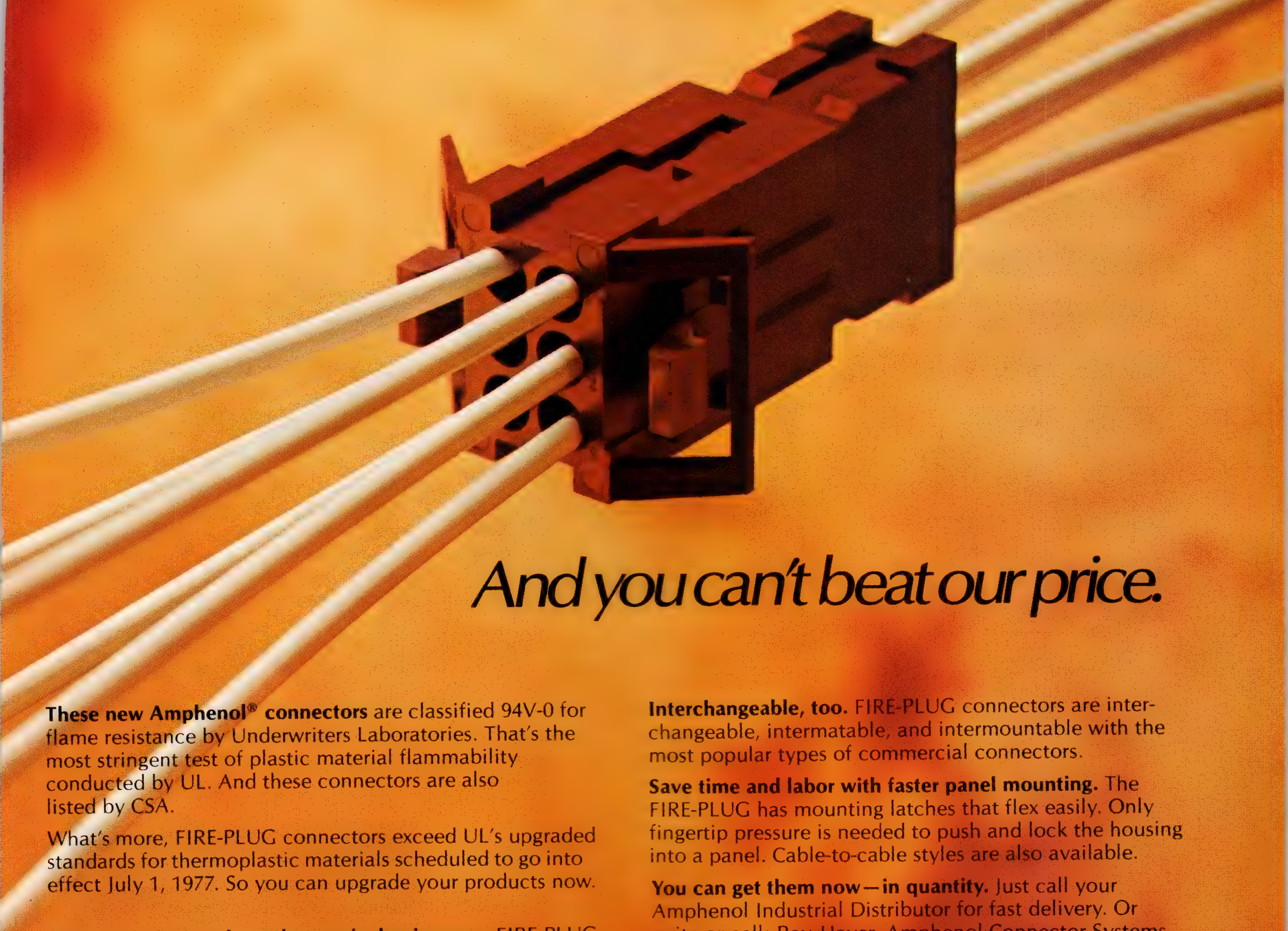

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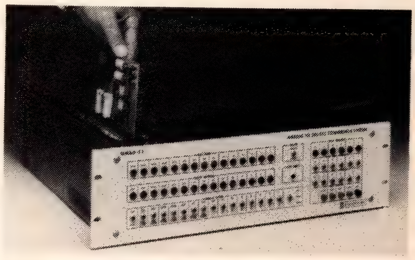
COMPUTERS/PERIPHERALS

ANALOG I/O SYSTEM. Input (MP 7208 and MP 7216) and output (MP 7104) boards interface Motorola's EXORciser to analog inputs and outputs. The MP 7208 (8-channel differential input) and MP 7216 (16-channel single-ended input) have resistor-programmable input ranges from ±10 mV to ±10V, allowing them to connect directly to low-level signal sources. $695 (1-4); $295 (100). Delivery, 4-6 wks. ARO (small qty.). **Burr-Brown,** Box 11400, Tucson, AZ 85734. Phone (602) 294-1431. **Circle No. 188**

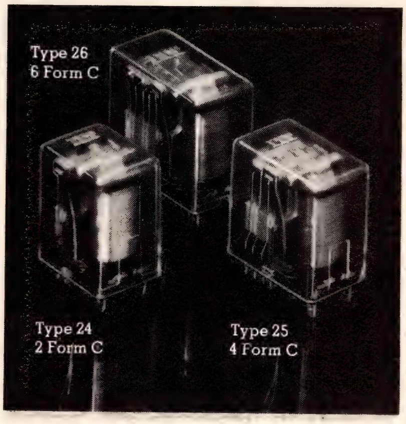
TERMINAL. Thanks to μP logic, the LX1010 programmable interactive terminal "talks" with any computer processor. Users can employ ASCII, BCD, correspondence or other character sets and transmit either synchronously or asynchronously at rates from 75 to 4800 bits/sec in full/half duplex or echoplex modes. Standard print speed equals 180 characters/sec. $6000. Delivery, 30-60 days. **LogAbax,** 10889 Wilshire Blvd., Los Angeles, CA 90024. Phone (213) 477-0494. **Circle No. 189**

LSI-11 INTERFACES. A wide range of interface and logic modules for the LSI-11 includes general-purpose logic modules such as the 1710 GPIO and the 11B DMA controller, as well as the WWBI and 11WWB dual and quad wirewrap modules. Input/output modules are the LP11 line printer, CR11 card reader and PC11 paper-tape reader/punch controllers. Communications modules include the DLV11 asynchronous and DUV11 synchronous serial line interfaces. **MDB Systems, Inc.,** 1995 N. Batavia St., Orange, CA 92665. Phone (714) 998-6900. **Circle No. 190**

MODEM. The Pennywhistle 103 acoustic coupler is believed to be the first modem in kit form. Operating in either half- or full-duplex mode, it can be used as an acoustic coupler (with telephone headset) or be wired directly into the telephone via a DAA. Chassis parts, speakers, grilles, muffs and all parts come with the kit. All components mount on a single 5×9-in. card. $109.95. **M&R Enterprises,** Box 61011, Sunnyvale, CA 94088. Phone (408) 738-3772. **Circle No. 191**



A/D CONVERTER. The GMD-10/1000 yields either 10-, 12- or 15-bit resolution with up to 1024 channels or more. Designed for interfacing with many popular minicomputers, the converter's spec's include dc to 60-kHz bandwidth, CMR of 120 dB at a gain of 1000, noise <2-μV RTI, and drift <1-μV/°C RTI. The standard unit contains the converter, clock, addressing circuits, power supply and up to 30 differential amplifier-filter channels. **Preston Scientific, Inc.,** 805 E. Cerritos Ave., Anaheim, CA 92805. Phone (714) 776-6400. **Circle No. 192**



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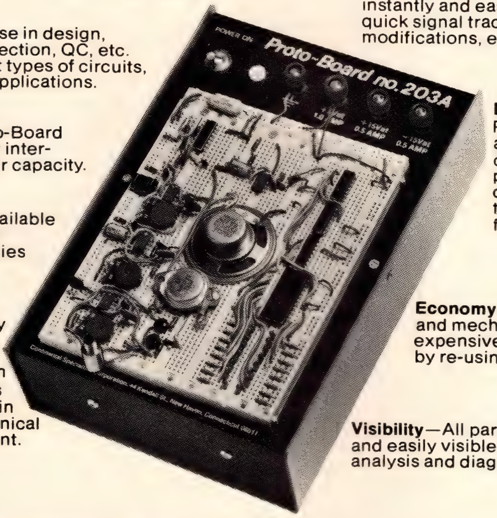

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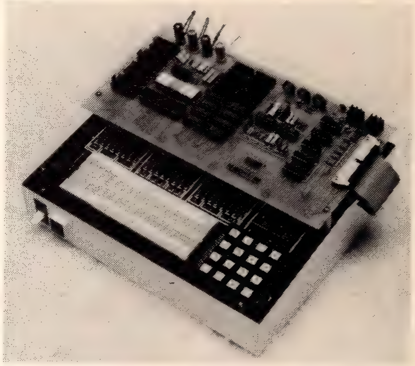
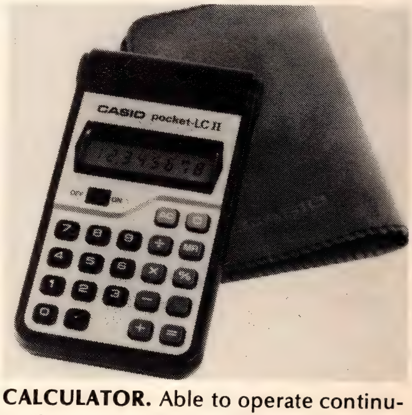
COMPUTERS/PERIPHERALS



μC ACCESSORY BOARD, MMD-1/MI, plugs into the built-in card-edge connector on the MMD-1 educational μP board, increasing on-board memory to 2.5k RAM and 1.5k PROM or ROM. The MMD-1/MI offers: 2k RAM capability (1k supplied), TTY interface (20-mA loop), paper-tape reader control for ASR33's, audio-cassette interface, and sockets to accept up to 1k PROM or ROM. Assembled, $200; kit, $150. **E & L Instruments Inc.,** 61 First St., Derby, CT 06418. Phone (203) 735-8774.

Circle No. 193



CALCULATOR. Able to operate continuously for 600 hrs. on a single alkaline battery (250 hrs. on a normal battery), the Pocket-LC II provides all 4 functions with 8-digit accuracy. The unit's secret?—an ultra-low power FE-type liquid-crystal display. This calculator also features an independent memory as well as a percent key. $19.95. **Casio, Inc.,** 15 Gardner Rd., Fairfield, NJ 07006. Phone (201) 575-7400. **Circle No. 194**

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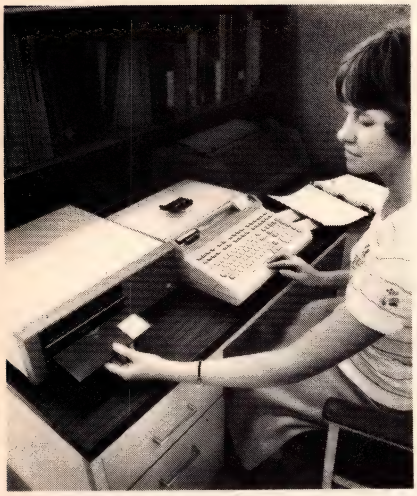

DISC DRIVES. The 9885M (master) and 9885S (slave) flexible-disc drives, which expand the usefulness of the HP 9825 programmable desktop calculator, have a memory capacity of up to 468,480 bytes/disc. Each 9885M, with its built-in controller, can manage the operations of up to 3 9885S slave units simultaneously. The 9825 can direct up to 8 9885M units. 9885M, $3900; 9885S, $2500. **Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, CA 94304. Phone (415) 493-1501. **Circle No. 196**

PROGRAM EXCHANGE. Designated the PPX-52, this professional program exchange makes hundreds of specialized programs available to SR-52 owner/members. Documentation sent includes a submission abstract, program description, sample problem, user instructions and a program listing. The $15 annual membership fee also entitles users to a catalog of available programs, catalog updates and a bimonthly newsletter. **Texas Instruments Inc.,** PPX-52, Box 22283, Dallas, TX 75222. Phone (214) 238-2011. **Circle No. 197**

MULTIPLEXER. This asynchronous multiplexer board allows for the installation of up to 64 asynchronous channels in 1 processor. Each channel is RS-232C compatible and will interface to local terminals or data sets in half or full duplex. Eight baud rates, from 110 to 9600, are jumper-selectable. The real-time clock (operating under program control), provides crystal-controlled interrupts of 1000, 100 and 60 Hz. $2995. Delivery, 30 days ARO. **STC Systems Inc.,** 9 Brook Ave., Maywood, NJ 07607. Phone (201) 845-0500. **Circle No. 198**

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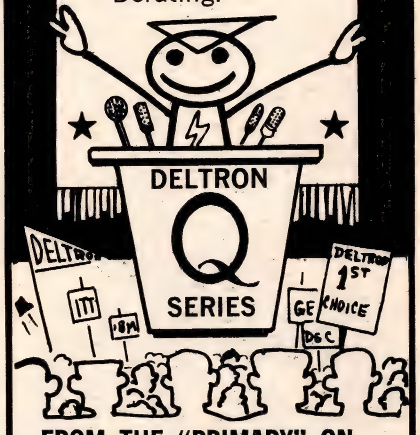

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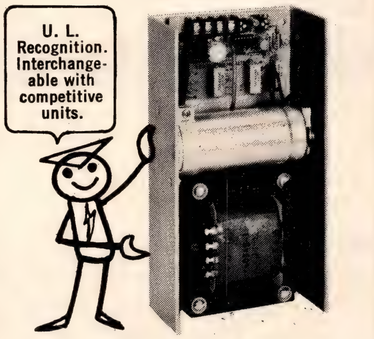

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volts—amps	volts—amps	volts—amps	volts—amps	volts—amps
Q 5— 3.0	Q 5— 6.0	Q 5— 9.0	Q 5—12.0	Q 5—18.0
Q 6— 3.0	Q 6— 6.0	Q 6— 9.0	Q 6—12.0	Q 6—18.0
Q 12— 1.7	Q 12— 3.4	Q 12— 5.7	Q 12— 7.0	Q 12—10.8
Q 15— 1.5	Q 15— 3.0	Q 15— 4.8	Q 15— 6.3	Q 15— 9.5
Q 18— 1.3	Q 18— 2.6	Q 18— 4.0	Q 18— 5.2	Q 18— 7.8
Q 20— 1.3	Q 20— 2.6	Q 20— 4.0	Q 20— 5.2	Q 20— 7.8
Q 24— 1.2	Q 24— 2.4	Q 24— 3.3	Q 24— 4.8	Q 24— 7.2
Q 28— 1.0	Q 28— 2.0	Q 28— 3.1	Q 28— 4.2	Q 28— 6.0
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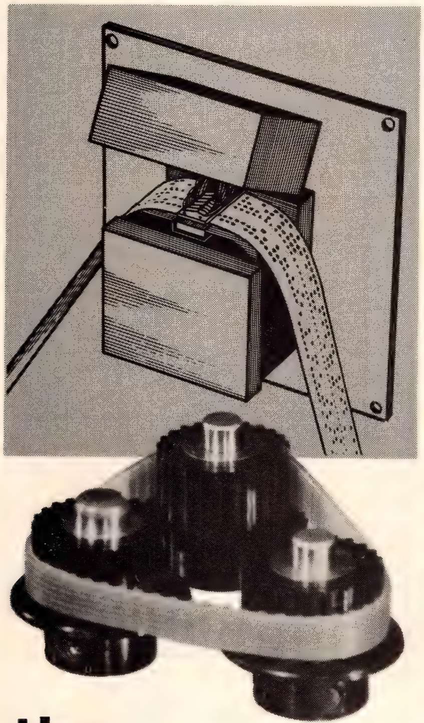

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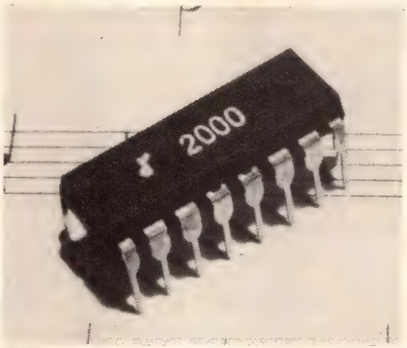
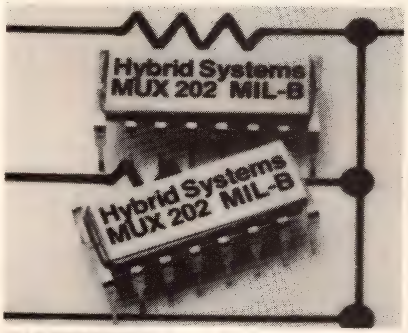
IC'S/SEMICONDUCTORS



AMPLIFIER. Reported to be the first dual linear-antilog, voltage-controlled amplifier offered in a 16-pin DIP, SSM 2000 is a dual 2-quadrant multiplier with each channel having separate control and differential signal inputs and current output. This unit offers control accuracy at 1% over the entire 80-dB range, and its dual design allows completely independent selection of the 2 channels' control characteristics. $6 (1-24). **Solid State Music,** 2102A Walsh Ave., Santa Clara, CA 95050. Phone (415) 941-2820. **Circle No. 199**

µP PERIPHERALS. TMS 9901, a programmable systems interface (NMOS), can be used with 9900 or 9980 µP's. TMS 9902 UART can use the CRU I/O port of the 9900 or 9980. Its programmable data rates run from 5 to 76,800 bps. TMS 9903 performs synchronous communication control and also interfaces to the 9900 and 9980 via the CRU I/O port. Model 9904, a 4-phase clock generator and driver for the TMS 9900, also generates 4 TTL-level clock phases to drive the 9901/02/03. **Texas Instruments, Inc.,** Box 5012, MS/84, Dallas, TX 75222. Phone (713) 494-5115. **Circle No. 200**

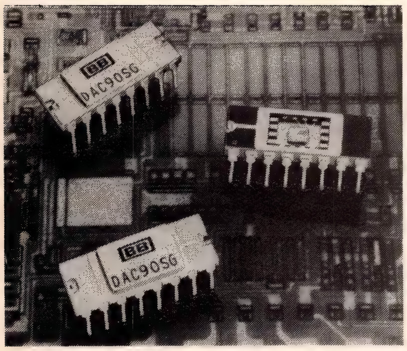


MULTIPLEXERS. Models MUX 202-M and MUX 203 are 8-channel, single-ended multiplexers which combine accuracy and high speed in a 16-pin hermetic DIP. These devices have overvoltage protection on both analog and digital inputs, and are also protected against channel interaction when power is removed. Key specs include: 0.01% accuracy, 0.01% cross talk (at 10 kHz), and 0.5-µsec address time. MUX 202-M/B, $65; 203, $19 (1-9). **Hybrid Systems Corp.,** Crosby Dr., Bedford, MA 01730. Phone (617) 275-1570. **Circle No. 201**

ANALOG IC'S. SE515, a mil-spec'd differential amplifier, offers excellent input-parameter stability, large gain-bandwidth, and differential input/output. The amplifier comes in a 14-pin ceramic DIP or 10-pin TO-5 package. DM7820, a dual-line receiver, accepts a wide range of input voltages and operates from a single 5V battery. It is housed in a 14-pin ceramic DIP. SE515F/883B, $14.63; DM7820F/883B, $22.68 (100). **Signetics,** 811 E. Arques Ave., Sunnyvale, CA 94086. Phone (408) 739-7700. **Circle No. 202**

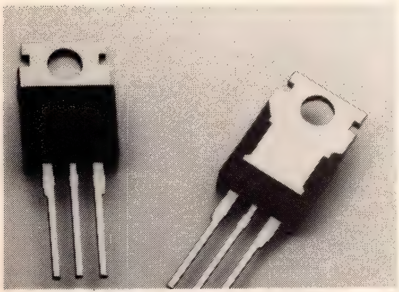
HYBRID IC'S. Hybrid amplifiers MC5107 and 5108 for CATV use have bandwidths of 30-300 MHz with a slope of 1 dB. Passband ripple is ±0.1 dB, typ.; noise figure, 8.5 dB. Broadband hybrid amplifiers MC5120 and 5121 cover a 30-890 MHz bandwidth. The MC5120 provides 21-dB gain; the 5121, 27 dB. MC5120, $6.25; 5121, $7. **California Eastern Labs., Inc.,** Box 915, Burlingame, CA 94010. Phone (415) 342-7744. **Circle No. 203**

TRANSISTORS. Model HXTR-6102 bipolar, low-noise microwave transistor has a guaranteed noise figure of 2.7 dB max. at 4 GHz, (2.5 dB, typical). Associated gain is 9 dB, and the low noise results from sub-micron emitter widths. Price reductions on the companion HXTR-6101, a recently introduced microwave transistor, are up to 33%. Both devices are housed in metal/ceramic hermetic packages. HXTR-6101, $87; 6102, $130 (10-24). **Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, CA 94304. Phone (415) 493-1501. **Circle No. 204**



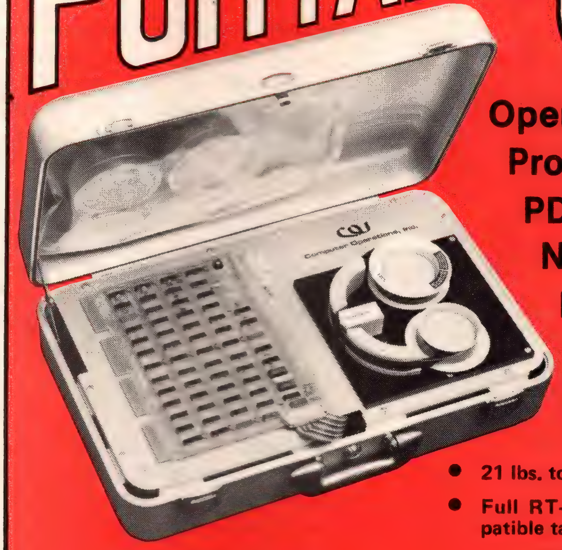
D/A CONVERTER. Settling time of the 8-bit DAC90 (to ±0.2%) is 200 nsec; nonlinearities, < ±0.2% (over specified temperature ranges); and gain drift, typically ±50 ppm/°C. Two temperature versions are available: DAC90BG, −25 to +85°C; and DAC90SG, −55 to +125°C. Both are current-output devices and come in a hermetic 16-pin ceramic DIP. 90BG, $8.50; 90SG, $12.50 (100). **Burr-Brown,** International Airport Industrial Park, Box 11400, Tucson, AZ 85734. Phone (602) 294-1431. **Circle No. 205**

DRIVERS. Peripheral drivers of the 55/75470 family feature output-current capability of 300 mA with no latch-up problems at 55V dc, and are pin-for-pin replacements for the 55/450 and 55/460 Series units. All versions are fully compatible with TTL/DTL logic, and have typical ac switching speed of 45 nsec. Plastic: 75470, $1.23; 75471-74, 81¢ (100). **Fairchild Camera and Instrument Corp.,** Analog Div., 464 Ellis St., Mt. View, CA 94042. Phone (415) 962-3816.
Circle No. 206



THYRISTORS. Housed in TO-220 plastic packages, the 25A Series 2N6504-6509 SCR's have peak reverse-voltage ratings from 50 to 800V. All units also feature a peak nonrepetitive surge-current rating of 300A. The 2N6504 (V_{RRM} = 50V), in quantities of 100, is priced at $1.43; 2N6509 (800V), at $4.95. **Motorola Semiconductor Products, Inc.,** Box 20294, Phoenix, AZ 85036. Phone (602) 244-3454. **Circle No. 207**

PORTABLE CQU



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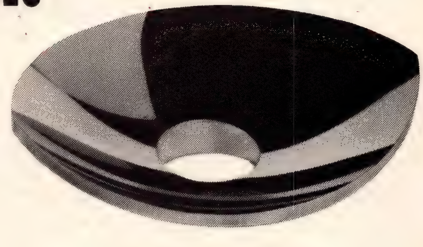

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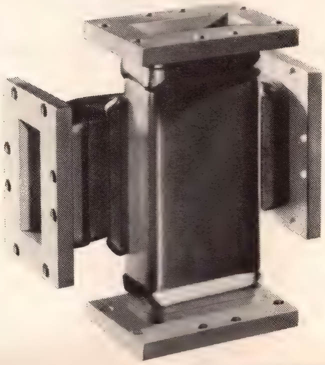

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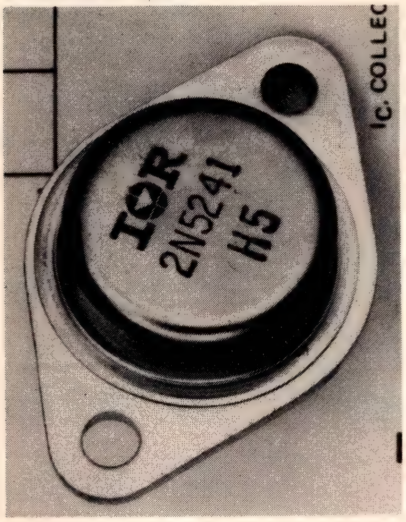
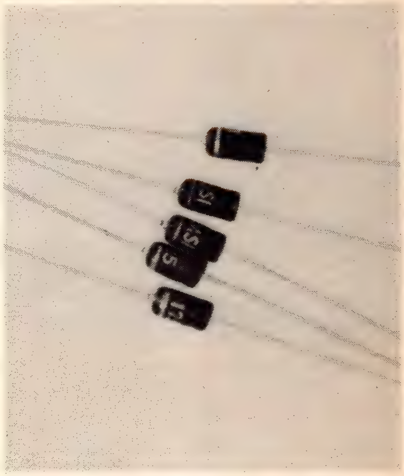
IC'S/SEMICONDUCTORS



TRANSISTORS. Series-2N5241 power transistors are rated at 400V and 125W. Collector current ratings are 5A continuous, with max. dc current gain of 35 at I_C = 2.5A. Turn-on time is 0.8 μsec; turn-off time, 1.7 μsec. Intended for use in chopper regulators, automotive ignitions, and high-voltage supplies, these are housed in the JEDEC TO-3 metal case. $11.41 (100). **International Rectifier,** 233 Kansas St., El Segundo, CA 90245. Phone (213) 678-6281. **Circle No. 208**

TRANSISTORS. These 12.5V UHF power transistors provide broadband performance in the 450-512 MHz range. All models withstand infinite VSWR (at any phase angle, 15.5V dc and rated output power), and are housed in low-inductance, stripline flange packages. CM10-12A (10W), $12.45; CM60-12A (60W), $34.20 (100). **Communications Transistor Corp.,** 301 Industrial Way, San Carlos, CA 94070. Phone (415) 592-9390. **Circle No. 209**

LINE RECEIVER. The 55/75154 quadruple line receiver meets RS-232C specs for interfacing between data-terminal equipment and data-communications equipment. Operation is from a single 5V (or 12V) supply, and the receiver's output is compatible with most TTL/DTL logic. Commercial versions are housed in either a ceramic or a plastic 16-pin DIP; military versions, in either a ceramic DIP or flatpack. Commercial units in plastic DIP, $2.48; ceramic DIP, $2.98 (100). **Fairchild Camera and Instrument Corp.,** Analog Div., 464 Ellis St., Mt. View, CA 94042. Phone (415) 962-3816. **Circle No. 210**



TUNING DIODE. Model MV1405 varactor diode provides a 10:1 capacitance tuning ratio, enabling 3:1 frequency coverage. Nominal capacitance at 2V bias is 250 pF, falling below 25 pF at 10V bias. The diode's breakdown rating of 12V, and its 1-MHz Q of 200 (min.) at 2V bias make it suitable for broad frequency tuning at lower RF frequencies, and for synthesizer applications. It is housed in a hermetically-sealed, glass JEDEC DO-7 package. $5 (100). **MSI Electronics Inc.,** 34-32 57th St., Woodside, NY 11377. Phone (212) 672-6500. **Circle No. 211**

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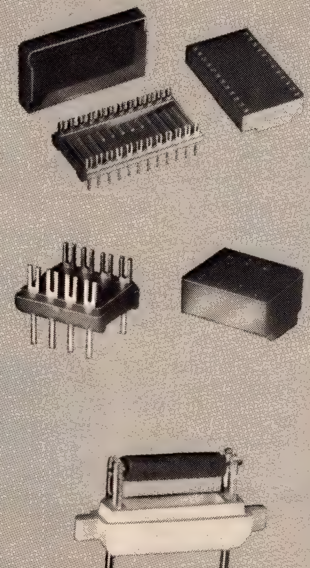

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Aries DIP Socket headers allow user to build his own custom modules for interposing discrete components anywhere in his system by plugging into Aries or other sockets. Headers may also be directly soldered into printed circuit board.

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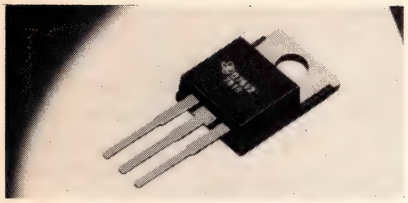
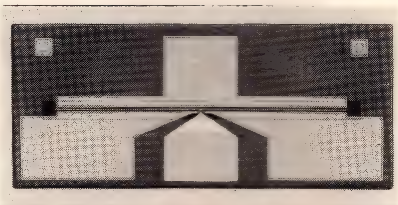


REGULATORS. The 7800- and 7900-Series 3-terminal positive regulators come with 7 fixed output-voltage ranges from 5 to 24V. All models include internal thermal overload protection, output-transistor safe-area protection, and internal short-circuit current limiting. These units, pin-for-pin equivalents to Fairchild's 7800 and 7900 Series, are housed in a plastic TO-220 package. $1.38 (100). **Texas Instruments Inc.,** Box 5012, M/S 308, Dallas, TX 75222. Phone (214) 238-3653. **Circle No. 212**

AMPLIFIERS. Wideband RF amplifiers, AMT7016/17/18/19, cover the frequency range of 1 MHz to 2000 MHz. Four gain options are available: 17, 22, 35 and 40 dB. Noise figure is 6.5 dB for each type. Other specs include: output power of either +10 or +16 dB, depending on model; VSWR of 2.5:1; and dc power of 15V at 80, 100 or 160 µA, depending on model. Units come in flatpack or (on special order) 22-pin DIP's. **Aertech Industries,** 825 Stewart Dr., Sunnyvale, CA 94086. Phone (408) 732-0880. **Circle No. 213**



GaAs FET CHIP. With its 14.5-dBm (25-mW) linear power output, 3.6-dB typical noise figure (6.9-dB associated gain), and 11.0-dB max. available gain at 10 GHz, the HFET-1000 chip is well-suited for general use in low-noise amplifiers in the 2- to 12-GHz range. The Schottky-barrier FET chip is said to show excellent consistency from one production run to the next. $105(10-24). **Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, CA 94304. Phone (415) 493-1501. **Circle No. 214**

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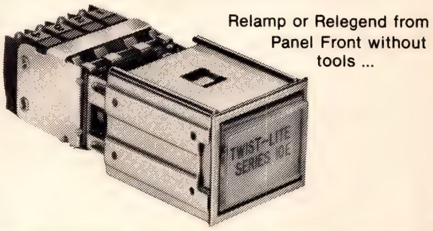

Series 10E Twist-Lite features positive hard-mount sleeve, individual lamp color control, and full, horizontal, vertical, or 4-way split displays. Up to 4-lines of engraved legend. Snap-on switch modules in alternate or momentary action with 2PDT or 4PDT; holding coil for electrical interlock. Solid state switching available. Optional accessories include switch guard, 4-color full-display, drip-proof seal, RFI screen, & test control capsules. Series 10H unit meets MIL-S-22885.

SERIES 90
2-Lamp Lighted Pushbutton Switches

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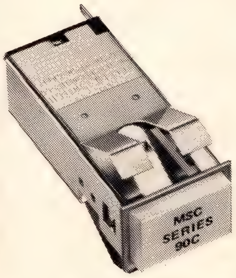
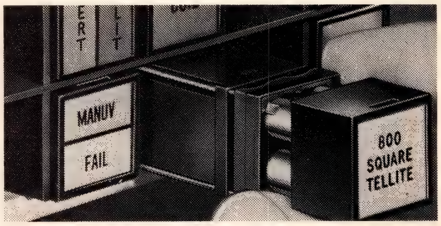


Three models offer choice of mounting tabs or snap-in spring clip mounting, as well as solder lug, double-turret or plug-in crimp-type terminals. Up to 3 lines of engraved legend. Indicator only or switch-lite units with integral alternate or momentary switch in SPDT, 2PDT or 4PDT; holding coil for electrical interlock. Series 90H units meet MIL-S-22885/58.



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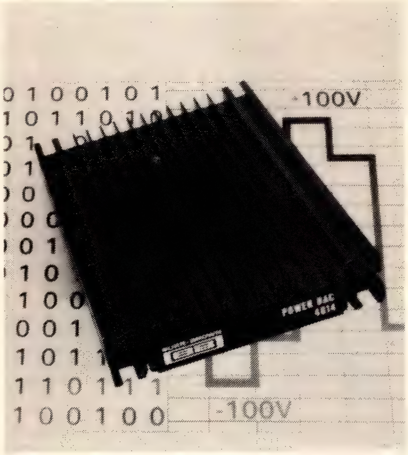
MODULES/SUBASSEMBLIES



POWER D/A'S. Combining a D/A with a power-output stage, these units provide resistor-programmable output ranges from ±10V to ±100V with 100-mA output current. Model 4814 (binary input) and 4815 (BCD input) accept 12 data bits plus 1 sign bit and achieve total accuracy of ±0.025% of F.S., gain drift of <±70 ppm/°C, max. settling time (to within 0.01%) of 100 µsec, and offset error of ±10 mV (trimmable to ±3 mV). $249. **Burr-Brown,** Box 11400, Tucson, AZ 85734. Phone (602) 294-1431.
Circle No. 166

ANALOG MULTIPLEXERS. Consisting of 2 single-ended and 2 differential models that accept 4, 8, or 16 input channels, the MX Series features CMOS construction, ±20V input- and ±4V logic-overvoltage protection, and break-before-make switching. With binary-coded logic inputs and inhibit capability, all models achieve transfer accuracies of 0.01% at channel-sampling rates to 200 kHz for inputs between ±10V. Price range, $14-$34. **Datel Systems, Inc.,** 1020 Turnpike St., Canton, MA 02021. Phone (617) 828-8000. **Circle No. 167**

DIGITAL CLOCK MOVEMENTS. MA1010 Series modules are available for either 50- or 60-Hz inputs and with either 12- or 24-hr display formats. Each includes the MOS IC, a power supply and other components on a single pc board not much bigger than its 4-digit direct-drive 0.84-in. high LED display. The user need only add a transformer and switches to construct a pre-tested clock suitable for mounting in other equipment. $15-$16.50 (100). **National Semiconductor Corp.,** 2900 Semiconductor Dr., Santa Clara, CA 95051. Phone (408) 737-5000.
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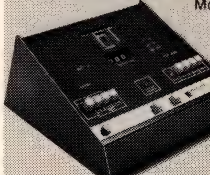
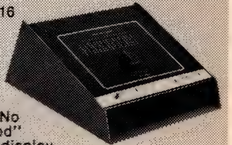


Model 1234 Linear IC Tester.
Devices tested: Monolithic or Hybrid Operational amplifiers.
Tests performed: E_{os}, I_{B-}, I_{B+}, DC open loop gain, DC CMRR, oscillation detection.
Remarks: 3-digit direct reading digital display which enables go-no-go testing.



Model 1248 Digital IC Tester.
Devices tested: 14 and 16 pins, TTL, DTL and CMOS @ 5V. Tests performed: Fixed pattern functional test.
Remarks: Performs 2^{20} inspections per test in from 1 to 5 seconds. No comparison with a "good" IC is necessary. 4-digit display gives absolute test results. Can also be used to check continuity of resistor network.

Model 1249 Digital IC Tester.
Devices tested: TTL, DTL @ 5V, HTL @ 15V, CMOS @ 5V, 10V, 15V.
Tests performed: Same as 1248. Remarks: Interfaces with manual and automatic handlers. Multiple voltages for CMOS.

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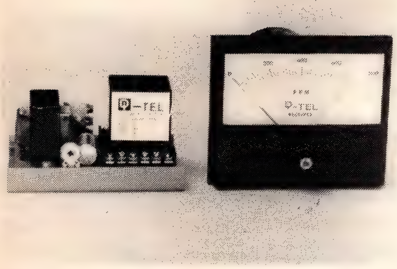

TELEMETRY SYSTEM. Accommodating F.S. inputs from 50 to 500 mV, the DI-TEL's Transmitter drives a VCO at between 300 and 2300 Hz. A receiver system—which may indicate, record or control—demodulates the FM carrier and displays the output on an analog or digital panel meter. Both the transmitter and receiver (exclusive of panel meter) afford accuracy and linearity of better than 1%. Price, from $330 for indicating systems. **Dallas Instruments, Inc.,** Box 38189, Dallas, TX 75238. Phone (214) 341-0504. **Circle No. 169**

WIDEBAND AMP. Packaged in a standard 16-pin DIP and suitable for integration into instruments such as A/D's and counter timers, the dc-coupled Type VV100 (1-nsec rise time) and VV101 (2-nsec) offer fixed noninverting gains of 10, cascadable to 1000X. Specs also include dc offset TC of <100 μV/°C and 0.1% integral linearity for outputs up to ±5V. $57 (VV101). **LeCroy Research Systems,** 700 S. Main St., Spring Valley, NY 10977. Phone (914) 425-2000. **Circle No. 170**

S/D CONVERTERS. Accepting 1:36 (or 2:36) 2-speed synchro or resolver information up to 720°/sec and over a frequency range of 50 to 1200 Hz, the 168C500-family units supply 16-bit resolution with ±0.41-minute (worse-case) accuracy. All units need no trimming or adjustments and are fully encapsulated in 2.625×3.125×0.82-in. packages. $850. **Control Sciences Inc.,** 8399 Topanga Canyon Blvd., Suite 303, Canoga Park, CA 91304. Phone (213) 887-7344. **Circle No. 171**

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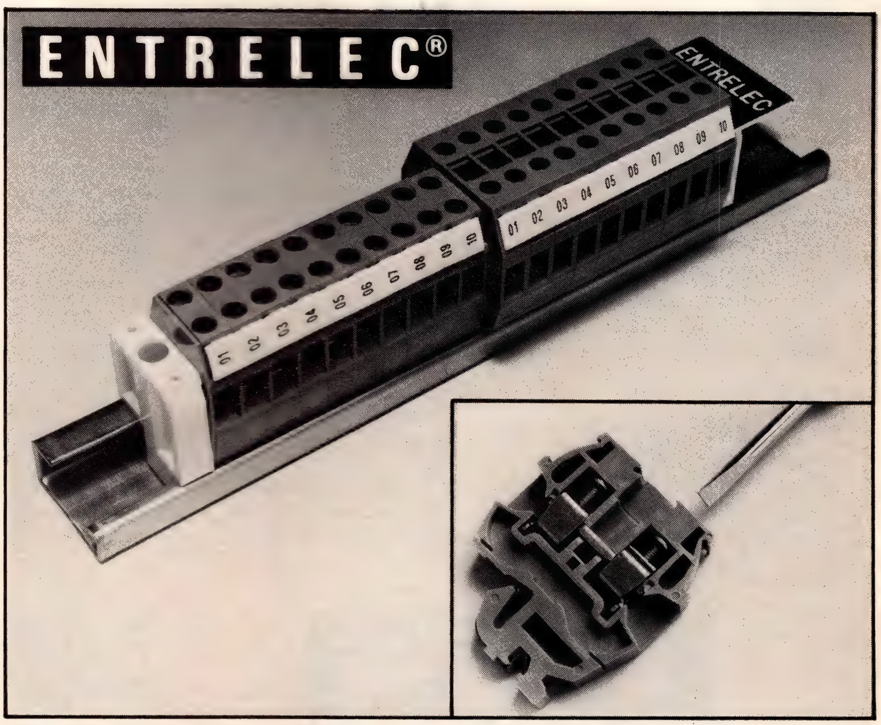

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For more information, Circle No. 91

LITERATURE

BROADBAND POWER AMPS. Describing designs for 4 high-performance UHF amps, Application Paper 2.1.8.6D offers technical insight into UHF design, construction hints, circuit photos, schematics and parts lists. All 4 state-of-the-art 12V designs operate in the 450 to 512-MHz frequency range. **Communications Transistor Corp.,** 301 Industrial Way, San Carlos, CA 94070. **Circle No. 215**

IR CALCULATOR. A free 20-scale paperboard slide rule provides order-of-magnitude results for infrared-radiation calculations. Commonly needed symbols, constants and equations are included, making the temperature and energy conversions both easier and more convenient. A companion guide works through 7 case problems. **Sensors, Inc.,** Box 1383, Ann Arbor, MI 48106. **Circle No. 216**

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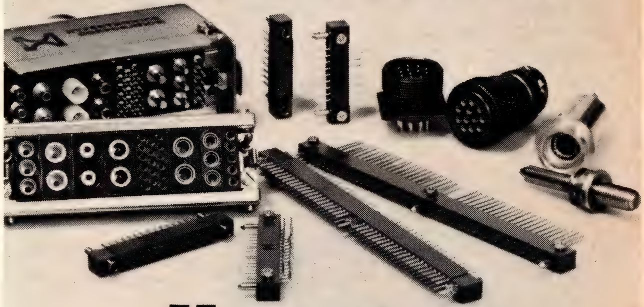

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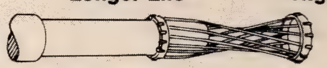

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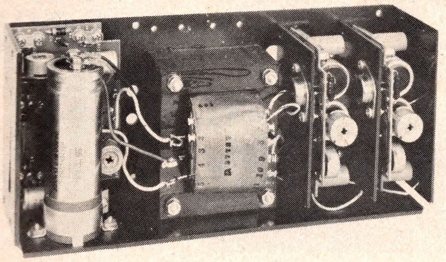

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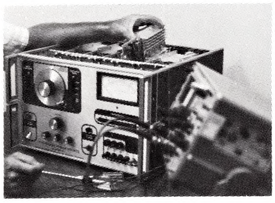

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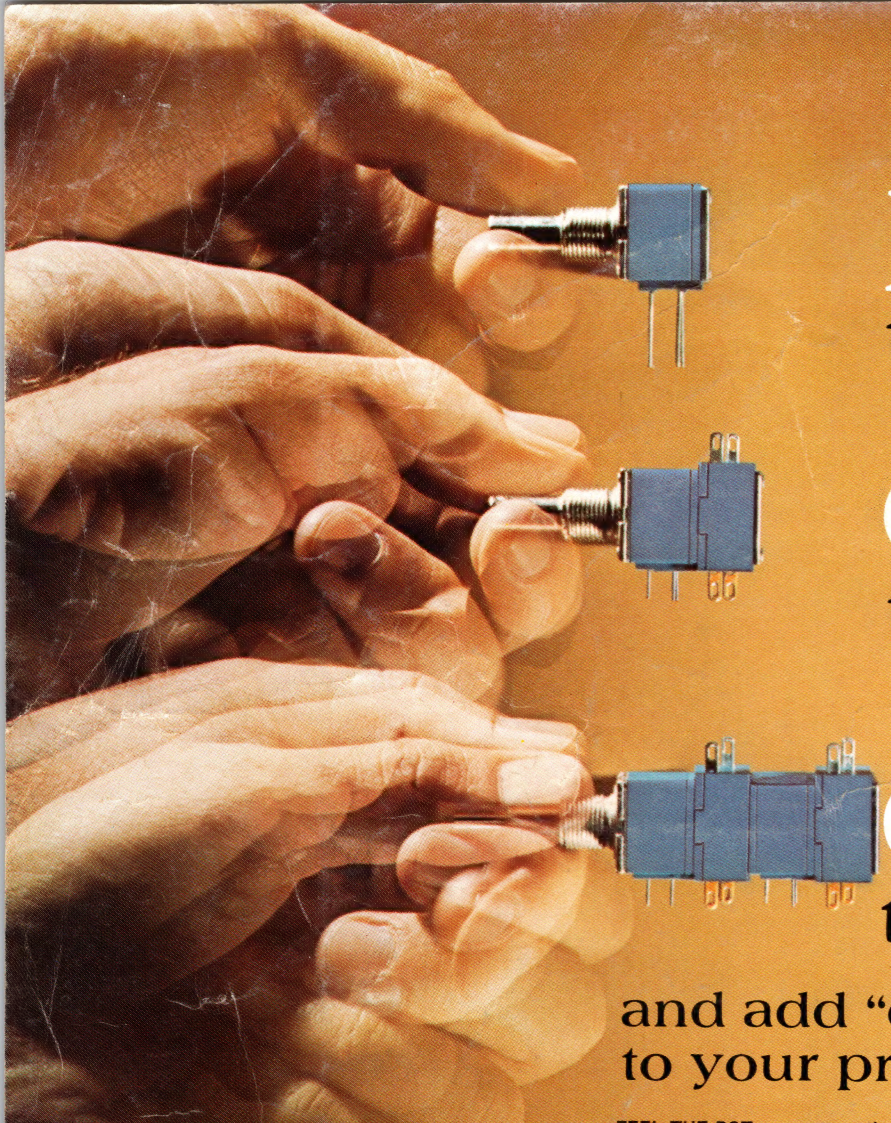

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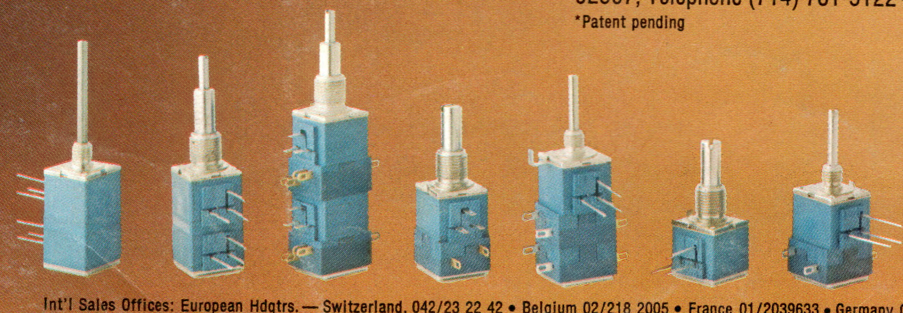

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